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The Réideschbaach Fossil Fauna

Ben Thuy & Christian Franke (editors)

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Contents

Editorial

Die paläontologische Forschung ist getrieben von einer unstillbaren Neugier nach neuen Erkenntnissen, die unseren Horizont über das Leben vergangener Epochen auf unserem Planeten erweitern. Fundstellen, wie die vom Réideschbaach bei Heiderscheid im Luxemburger Oesling, versprechen durch den guten Erhaltungszustand der bislang aufgesammelter Fossilien und einer Reihe neu entdeckter Arten natürlich einen Zugewinn an Wissen über einen noch relativ weißen Fleck auf der paläontologischen Karte des Großherzogtums.

Mit der Untersuchung der "Réideschbaach-Fauna" haben wir einen weiteren wichtigen Meilenstein in der Erforschung des südlichen Abschnittes des Luxemburger Oesling beschritten.

In diesem Band werden ausführliche Überlegungen zum geologischen Kontext ebenso wie die Studien über den Großteil der "rheinisch-herzynischen Mischfauna", wie die Trilobita, Brachiopoda, Bivalvia und Crinoida vorgetragen. Einige Vertreter dieser Réideschbaach-Fauna, unter anderem Ostracoda und Bryozoa sollen zu einem späteren Zeitpunkt veröffentlicht werden.

Auch wenn nicht bei jeder Grabung der Sensationsfund gemacht werden kann, so sind es die vielen kleinen Mosaiksteinchen im Rekonstruktions-Puzzle eines erdgeschichtlich interessanten Lebensraumes die das eigentliche Vermögen einer derartigen Unternehmung rechtfertigen.

Alle Wissenschaft ist vorläufig und so werden neue Erkenntnisse im Laufe der Zeit folgen.

Sowohl die Grabung im Herbst 2021 als auch die Zusammenstellung der Beiträge dieses Bandes erfolgten im Rahmen einer Zusammenarbeit zwischen dem Nationalmuseum für Naturgeschichte Luxemburg und der Palaeontologica Belgica. Dem internationalen Team mit Beteiligten aus Belgien, Deutschland, den Niederlanden und Luxemburg gelang es unter der tatkräftigen Unterstützung des Naturparks Öewersauer durch Herrn Frank Richarz erstmals tiefer in die Geheimnisse des unteren Unter-Devon am Südrand des Givonne-Oesling-Antiklinoriums einzudringen.

La recherche paléontologique est animée par une curiosité insatiable pour de nouvelles découvertes qui ouvrent nos horizons sur la vie des époques passées sur notre planète. Des sites comme celui du Réideschbaach près de Heiderscheid dans l’Oesling luxembourgeois promettent naturellement, grâce au bon état de conservation des fossiles collectés jusqu’à présent et à une série d’espèces nouvellement découvertes, un accroissement des connaissances sur une tache encore relativement blanche sur la carte paléontologique du Grand-Duché.

Avec l’étude de la "faune du Réideschbaach", nous avons franchi une nouvelle étape importante dans l’étude de la partie sud de l’Oesling luxembourgeois.

Dans ce volume, des réflexions détaillées sur le contexte géologique sont présentées, tout comme les études sur la majeure partie de la "faune mixte rhéno-hercynienne", comme les trilobites, les brachiopodes, les bivalves et les crinoïdes. Certains représentants de cette faune de Réideschbaach, entre autres les ostracodes et les bryozoaires, seront publiés ultérieurement.

Même si la découverte sensationnelle ne peut pas être faite à chaque fouille, ce sont les nombreuses petites pièces de la mosaïque dans le puzzle de la reconstruction d’un habitat intéressant pour l’histoire de la Terre qui justifient la fortune réelle d’une telle entreprise.

Toute science est provisoire et de nouvelles découvertes suivront donc au fil du temps.

Tant les fouilles de l’automne 2021 que la compilation des contributions de ce volume ont été réalisées dans le cadre d’une collaboration entre le Musée national d’histoire naturelle du Luxembourg et la Palaeontologica Belgica. L’équipe internationale, composée de participants belges, allemands, néerlandais et luxembourgeois, a réussi, avec le soutien actif du Parc Naturel de la Haute-Sûre par l’intermédiaire de Monsieur Frank Richarz, à pénétrer pour la première fois plus profondément dans les secrets du Dévonien Inférieur sur la bordure sud de l’anticlinorium de Givonne-Oesling.

Die Ergebnisse des derzeitigen Forschungsstandes bestätigen ein Alter für die Réideschbaach-Schichten im tiefsten Unter-Emsium. Sie können als ein Richtstab für die weitere Erforschung dienen, der wir mit Spannung und Freude entgegensehnen.

Wir danken Herrn Nico Mayer-Schaltz für seine bemerkenswert sorgfältigen Baggerarbeiten während der Grabung, den Teilnehmern der Grabung (Ayla Debraekeleer, Yan Gillen, Anthonie Hellemond, Ivo Kesselaer, Frederik Lerouge, Peter & Martin Müller, Kevin Nolis, Markus Poschmann, Charel Rollinger, Anjin Thill, Allart van Viersen, Johan Vellekoop) sowie den Herren Martin Basse/ Bochum, Dr. Ulrich Jansen/ Forschungsinstitut Senckenberg Frankfurt a. M. und Dr. G. Heumann/ Steinmann Institut Uni Bonn für ihre fachliche Unterstützung.

Les résultats de l'état actuel des recherches confirment un âge pour les couches du Réideschbaach dans l'Emsien inférieur le plus profond. Ils peuvent servir de repère pour la poursuite des recherches, que nous attendons avec impatience et plaisir.

Nous remercions M. Nico Mayer-Schaltz pour son travail de pelleteuse remarquable pendant la fouille, les participants à la fouille (Ayla Debraekeleer, Yan Gillen, Anthonie Hellemond, Ivo Kesselaer, Frederik Lerouge, Peter & Martin Müller, Kevin Nolis, Markus Poschmann, Charel Rollinger, Anjin Thill, Allart van Viersen, Johan Vellekoop) ainsi que MM. Martin Basse/ Bochum, Dr. Ulrich Jansen/ Forschungsinstitut Senckenberg Frankfurt a. M. et Dr. G. Heumann/ Steinmann Institut Uni Bonn pour leur soutien scientifique.

Dr. Christian Franke & Dr. Ben Thuy

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NATURPARK ÖEWERSAUER

A geological context for the Réideschbaach Fossil Fauna

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Zusammenfassung

In diesem Kapitel untersuchen wir den geologischen Rahmen der Fundstelle Réideschbaach anhand der vorhandenen Literatur und eines Vergleichs mit den Bodenproben, die bei den Exkursionen im Jahr 2021 entnommen wurden. Ziel dieser Studie ist es, einen sedimentologischen und paläo-ökologischen Kontext für die zahlreichen Fossilien zu erarbeiten, die in den vergangenen Jahrzehnten an diesem Ort gefunden wurden. Zu diesem Zweck wurde eine Fluoreszenz-Röntgenanalyse (pXRF) an den entnommenen Proben durchgeführt.

Abstract

In this chapter we discuss the geological framework of the Réideschbaach site based on literature and compared to the samples that were taken during fieldwork in 2021. The scope of this research is focused on providing a sedimentological and paleo-environmental context for the many fossils that were found in this site over the past decades. In order to do so, an x-ray fluorescence analysis (pXRF) was performed on the retrieved samples.

Résumé

Dans ce chapitre, nous examinons le cadre géologique du site de Réideschbaach en nous appuyant sur la littérature et en comparant les échantillons prélevés lors des fouilles de terrain en 2021. L'objectif de cette étude est de fournir un contexte sédimentologique et paléo-environnemental pour les nombreux fossiles qui ont été trouvés sur ce site au cours des décennies précédentes. A cette fin, une analyse radiographique par fluorescence (pXRF) a été réalisée sur les échantillons prélevés.

1 Introduction

Over the course of circa 20 years, the Réideschbaach site has yielded some exquisitely preserved trilobites, including four new trilobite taxa for the Grand Duchy of Luxembourg, collectively referred to as the 'Réideschbaach Fossil Fauna'. This fauna is remarkably diversified and taphonomically well-preserved, providing valuable insights into the biostratigraphy of the southern margin of the Rheno-hercynian zone. The majority of these fossils were found in rocks along the banks of the Fél stream (the parent river or main stem of the Réideschbaach stream). Crucially, previous finds, mostly collected and reported between 2006 and 2010, were mainly gathered ex-situ (Basse & Franke 2006). Hence, so far no in-situ sampling of the 'Réideschbaach Fossil Fauna' has occurred yet. Here, we search to understand the geological context of the Réideschbaach site and find out why we find this peculiar fauna here. We want to obtain insight into the depositional setting of the studied strata and answer the question how, and under which conditions, these strata were deposited. In order to do so, a field campaign was organized by the Luxembourg museum of Natural History to excavate and prospect in-situ strata along the Réideschbaach and Fél valleys near Heiderscheid (Wiltz canton - Éislek) From 4th - 9th November 2021. The field campaign was attended by an international team of German, Belgian, Dutch and Luxembourg researchers with the aim of collecting additional data and specimens to investigate the trilobite, and associated, fossil faunas of the Réideschbaach site. The lack of a clear outcrop within the Fél valley, proved to be problematic to assign different faunal elements to a specific succession of strata, hampering correlation to known outcrops in the broader region. Therefore, during this field campaign, an excavator was brought on site to expose a clear succession of strata, by digging several trenches. Even though rising groundwater and rain from the weeks prior to the campaign hindered sampling, we were able to study and sample 20 meters of stratigraphy from the Réideschbaach site. We try to link the fossil remains uncovered from this site to this stratigraphic profile. Following up on the 'Röntgendiffraktiometrische Untersuchungen' (X-ray diffraction research), performed by Lunkenheimer (1989: 50-53) on the fossil bearing concretions of the Réideschbaach site, we subjected the samples to portable X-ray fluorescence (p-XRF) analyses, in order to understand the depositional environment of the site, complemented by micro-XRF (µ-XRF) element mapping of selected nodules containing the 'Réideschbaach Fossil Fauna'. A p-XRF based elemental composition is a quick way to qualitatively assess any lithological changes and reconstruct major changes in the depositional environment, whereas µXRF analysis provides more insights in the distribution of trace and major elements in specific small samples. Together, the generated data provides us with an insight into the depositional setting of the studied strata, and the conditions under which the 'Réideschbaach Fossil Fauna' were deposited.

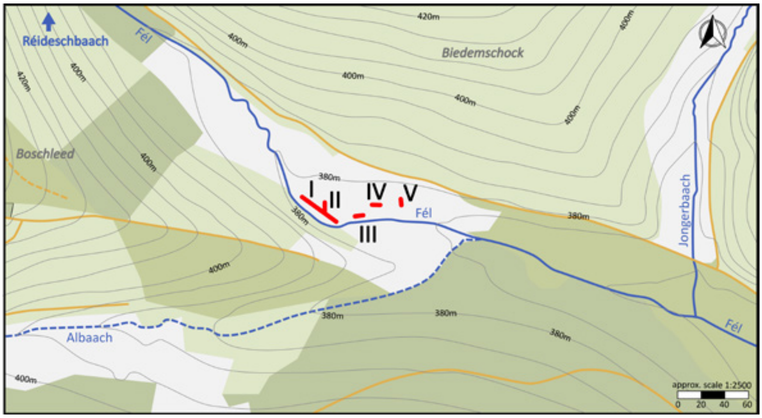

Fig. 1: Map of the Réideschbaach site along the Fél stream. This protected woodland near the Wiltz - Diekirch border, belongs to the Esch-sur-Sûre municipality and is a part of the Wiltz canton. The white alluvial plain was the main location for the 2021 field campaign to recover the Réideschbaach fossil fauna. Roman numerals I-V indicate the trenches that were dug out during fieldwork.

2 Geographical setting

The Réideschbaach site (49° 52' 49.5'' N; 6° 00' 28.0'' E), named after the eponymous stream, is actually situated along the upstream course of the 'Fél' ('Fehlchen or Félenerhecken') stream. From a hydrological perspective, the Réideschbaach and Fél streams are part of the 'Waark' system that drains the Redange and Diekirch cantons and belongs to the Alzette river (a tributary of the Moselle-Rhine basin). The valley runs in a general north-south to northwest-southeast direction between the 'Boschleed' hill in the west, the 'Biedemschock' hillside in the east and the 'Aspelt' hill in the south. The location of the digsite has an elevation of around 389 m (NAP) and the dig was conducted in a +/- 30 m broad part of the alluvial plain, just before the inflow of the temporal (seasonal) 'Alba(a)ch' stream (source: Géoportail de Luxembourg). Given the great natural importance of the digsite, the necessary permissions were obtained to allow the excavator to dig and maneuver without disturbing too much of the protected natural area. A total of 5 trenches were dug out to look for a suitable succession of strata during the field campaign (Fig 1). The rural and structural constitution of the valley made it rather difficult to gather data and specimens, or observe any geological features on a macroscopic scale. The very few steep hillside outcrops are overgrown with vegetation and have been affected by intense weathering, rendering it nearly impossible to extract samples for research without removing large parts of vegetation and overburden. Prior to this fieldwork, the only source of gathering data on the subsurface was basically reduced to ex-situ sampling the (transported) rocks within the banks or the bottom of Fél stream.

3 Geological context

3.1 Literature overview

A brief geological context for the Réideschbaach site has been documented in several paleontological papers (Basse & Franke 2006; Basse et al. 2006; Plusquellec &, Franke 2010) and their (bio) stratigraphical conclusions were adopted within the explanatory guides of the latest geological maps of the Wiltz, Clervaux and Esch-sur-Sûre regions (Dejonghe 2020; 2021; 2024). To this day (December 2023), the geological map of the Heiderscheid region (on scale 1:25.000) is not yet concluded. Geological map nr. 5 of Diekirch region, including the Réideschbaach site near Heiderscheid, will presumably be finished in two years from now (written communication by Léon Dejonghe). Previous geological research around the region has been undertaken by several Belgian, German and Luxembourg authors over the course of the last 77 years (i.a. Asselberghs 1946, Lucius 1950; 1955, Furtak 1965, Konrad & Wachsmut 1973, Waterlot et al. 1973, Bachtadse 1979, Faber 1982, Lunkenheimer 1989), who compared much of their direct or indirect observations upon the earlier (late-19th and early 20th century) works of amongst others: Rudolf Richter, Hans-Joachim Lippert, Gerhard Solle, Hans-Theodor Reuling, Ludwig Happel, Jean-Baptiste Julien d'Omalius d'Halloy, Johan(nes) Steiniger, Nicolas Weiss, André Hubert Dumont, Gustave Dewalque and Henri de Dorlodot (Lucius 1955). An unpublished thesis was presented by Christoph Lunkenheimer (Saarland university) in 1989, focusing on the tectonic, sedimentological and paleontological observations of the Heiderscheid region, including the previously mentioned Réideschbaach site. Aside from this thesis and the previously mentioned paleontological papers, no additional paleontological or geological research has been conducted specifically on the lithologies or outcrops of the Réideschbaach site or Réideschbaach-Fél valleys.

3.2 Geological context

The Réideschbaach site is situated within the Éislek region (also written as: Islek, Eisleck, Oesling or Ösling) and constitutes a part of the SE side of the Neufchâteau-Wiltz-Eifel Synclinorium. This synclinorium near the Éislek-Gutland border (Fig. 2A-C) is defined by the succession and occurrence of heavily folded lower Devonian strata along Belgian High-Ardennes slate Belt and German Eifel (Baeckeroot 1942; Lucius 1950, Dejonghe et al. 2017; Boulvain & Vandenberghe 2018). The main sedimentological provenance of the exposed strata can be attributed to the influx of erosional (detrital) products from the Brabant

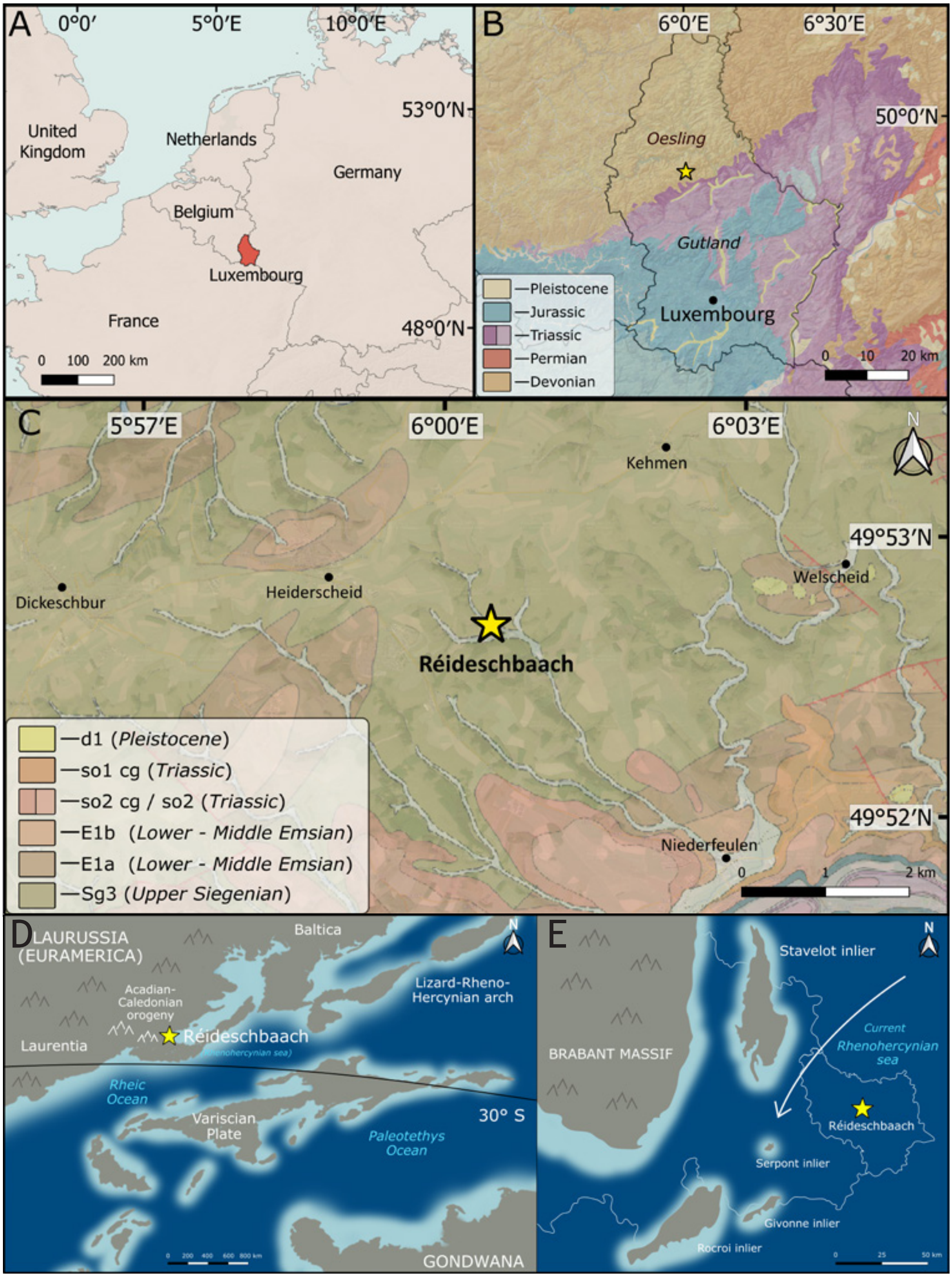

Fig. 2: A-C: Composite geological and paleogeographical map of the studied area, based upon the online harmonized geological map of the geoportail de Luxembourg. Note that the old 'Sg3' indication is still in use, referring to the strata as being Pragian (Siegenian) in age instead of Emsian. **D:** Paleogeographic map of the Réideschbaach site within its broader paleogeographical setting (Early Devonian). Freely based upon Ziegler 1990 and Deep Time maps 2020. **E:** Position of the Réideschbaach location within the Rhenohercynian sea (or ocean). Notice the relative close vicinity of the Laurussian (Euramerican) continent, represented here by the current lithotectonic borders of Brabant massif and the Stavelot, Serpont, Givonne and Rocroi inliers. The flow (current) of the Rhenohercynian sea (or ocean) follows a NE-SW direction.

Massif (Anglo-Brabant Fold Belt) in the north and the Mid-German (crystalline) High (MGCH) in the south (Stets & Schäffer 2002; Steemans 1989). The Rhenohercynian sea (Fig. 2D-E) in which these sediments were deposited, was a shallow and narrow but elongated marine basin (oriented NNE - SSW), paleogeographically situated on the southern hemisphere (McCann 2008: 12-13). Currents and flows within the Rhenohercynian sea also transported siliciclastic material from Baltica (the Baltic shield of the Old-red sandstone or Euramerican-Laurasian continent), which was deposited and retraced in several locations within the Ardennes-Éislek-Eifel region (Wagener 1989; Haverkamp et al. 1992) To lesser extent the weathering of nearby caledonian land masses within the Rhenohercynian basin, namely the Stavelot, Givonne, Serpont and Rocroi Massifs, have presumably also contributed to the filling of the basin. A detrital zircon analysis retracing the origin(s) of the lithologies within the Réideschbaach region, might be helpful in this regard to retrace distinct signals to specific continental (caledonian) entities, but a detailed provenance study has yet to confirm this.

The Réideschbaach site is a constituent of a much larger geological structure, known as the Rhenish massif (Vogel et al. 1987). This geological entity comprises the Ardennes, Éislek, Eifel, Taunus and Hunsrück regions and embodies a section of the Central European Variscides, a tectonically highly dynamic region during the variscan orogeny (Franke 2006). As a consequence of this dynamic setting, the entire region is highly affected by tectonic deformations, resulting in 'low' to 'very low' grade metamorphism (Fielitz & Mansy 1999). The metamorphism is defined as mainly anchizonal to slightly epizonal for the Emsian strata in the Luxembourg region (Mosar 1987). The Rhenohercynian basin itself evolved dynamically under the early variscan extension phase (EVEP) during the Devonian (Kroner et al. 2008). The Réideschbaach site and by extension the entire region, evolved from a tidal flat (Miwart Formation - Early Pragian) over deltaic-estuarine environments (Jupille (Pragian) and Clervaux (Middle-Emsian) Formations), to a more outspoken marine setting (Wiltz formation - Upper-Emsian), throughout the Early Devonian (Dejonghe et al. 2017).

Schistosity (foliation) in the area is almost parallel to the bedding plane and a deformation of the fossil fauna (a shortening perpendicular to the bedding plane, resulting in an elongation of the fossils) are almost omnipresent and linked to the tectonic and metamorphic evolution of the strata (Lunkenheimer 1989: 114). Specific tectonic structures such as boudinage, mullions (cuspate-lobate folds) were not observed within the Réideschbaach-Fél valleys. However, Lunkenheimer mentions the occurrence of 'ripple-mark like' tectonic structures in the Heiderscheid area, nonetheless without giving any exact location(s) for these observations (Lunkenheimer 1989: 113). This might be worth investigating more in depth, as these tectonic structures are classically well-known in the area North of the Troisvierges-Malsbenden backthrust (Urai et al. 2001; Kenis & Sintubin 2007; Van Noten 2011; Dejonghe 2013: 202-203), but have not yet been documented in the southern part of the Éislek region. Additional data on the brittle deformations of the Lower Devonian strata within the southern part of the Éislek, might allow us to obtain Insights into regional tectonic changes and the basin inversion of the Luxembourg part of the Rhenohercynian zone.

3.3 Stratigraphy and age discussion

An absolute dating for the strata exposed at the Réideschbaach site has not been established. Their relative age, as mentioned in several geological maps (Tab I), was based on distinct biostratigraphic index fossils (such as trilobites and bivalves) and has been historically compared to their Belgo-German lateral equivalents (Lucius 1955; Godefroid 1994; Jansen 2016). Ever since Dumont (1848-1849), the region around Heiderscheid, including the Réideschbaach site, were assigned either a Pragian (Siegenian, Taunusian, Hun(d)sruckian) or an Emsian (Ahrien, Daunian) age. The exact age of the strata, belonging to either the upper Pragian or the lower Emsian is still a point of debate as its lithostratigraphical transition is not clear (Dejonghe 2020: 11; 2021: 16-17; 2023:16). The current lower Emsian age, based on trilobite occurrences at the Réideschbaach site and their comparison with trilobite genera from the Cantabrian mountains (Spain) was initially proposed by Basse et al. (2006), and later adopted by Dejonghe et al. 2017; Dejonghe (2019; 2020; 2021; 2024) in the latest contributions to the geological map of Luxembourg. In this

Tab. 1: Overview of the main authors who contributed to the geological map of Luxembourg throughout the 19th, 20th and 21st century. This non-exhaustive list is based upon the classification (where possible) of the strata in the region of the Réideschbaach site.

Author(s) & Year	Country	Lithostratigraphic Name	Chronostratigraphical Entity/Stage
d'Omalius d'halloy (1808)	BELGIUM	Formation Ardoisière	Couches inclinées sans corps organisés*
Steiniger (1828)	GERMANY	Thonschiefer de transition & Grauwacke	Terrain primitif*
Dumont (1848-1849)	BELGIUM	Système Ahrien - Système Coblentzien	Terrain Rhénan (Hunsruckien)*
Wies & Siegen (1877)	GERMANY?	Grauwacke inférieure (D1)	Devonian
Dewalque (1879)	BELGIUM	Schiste de Houfalize et du Hundsrück Grès de Bastogne et du Taunus	Terrain Rhénan*
Gosselet (1885)	FRANCE	Phyllades De Trois Vierges	Taunusien*
Van Werveke (1896)	BELGIUM	Not mentioned	Lower Devonian
Dorlodot (1904)	BELGIUM	Quartozphyllade de Heinerscheid	Siegenien supérieur*
Lucius (1911)	LUXEMBURG	Schiefer von Kautenbach-Schiefer von Heinerscheid (Trois-Vierges)	Taunusien*
Asselberghs (1912, 1913)	BELGIUM	Formation de St. Vith	Rhénan*
Robert (1915)	LUXEMBURG	Phyllades de Troisvierges - Schischtes de Kautenbach	Upper Hunsruckien*
Asselberghs (1932)	BELGIUM	Facies de St Vith. Analog to Herdorfer Schichten (Siegerland) and Bergsteiner Schichten	Upper Siegenian*
Asselberghs (1946)	BELGIUM	-	Lower Emsian
Lucius (1947-1955)	LUXEMBURG	Formation de Sankt Vith - (Sg3)	Upper Siegenian*
Konrad & Wachsmut (1973)	GERMANY	Tonschiefer - Grauwacken Quartzit Wechselfolge (E1)	Upper Siegenian* - Lower Emsian
Lunkenheimer (1989)	GERMANY	Obere Tonschiefer Abfolge (OTA) (similar to: Reudelsterz Schichten)	Lower Emsian
Bintz & Maquil (1992)	LUXEMBURG	Schiste compact, grossier, mal Stratifié, avec des rares bancs de Grès Argileux (Sg3)	Upper Siegenian*
Colbach (2003)	LUXEMBURG	Formation De Grumelange (d2G)	Upper Siegenian*
Dejonghe et al. (2017)	BELGIUM	Our Formation (OUR)	Lower Emsian

*Non ICS units

article and Ferrantia volume, the strata exposed at the Réideschbaach site is considered to belong to either the lower Our Formation (OUR) and more specifically to the so-called Stolzembourg Member, or to the top of the Kautenbach-Troisvierges Formation (KAT). The lithostratigraphic setting of the Réideschbaach site is unclear at the moment. The Our Formation and the Kautenbach-Troisvierges Formation are hard to distinguish from each other in the field as there is no lithological marker that defines the borders between them. Both formations are generally characterized by shales, phyllites and mixed quartzite and phyllites including intercalations of thin and rare quartzitic sandstones. (Lucius 1949, 1950). These formations and their members should also be considered as sedimentary facies rather than lithostratigraphic entities (Muller 1980).

The Kautenbach-Troisvierges Formation, but especially the Our Formation, comprise a vast amount of strata with different lithofacies and biofacies (Hellemond et al. 2019: 4-5). From a paleontological perspective it would seem expedient to differentiate between different biofacies within the formations, in order to allow for a paleo-ecological reconstruction of the different biozones or environments. It would improve our insight into the shifts and differences in biota linked to certain paleo-environments and compare their overlaps and divergences. A useful tool in this regard would be to compare spores and palynological remnants with previous studies performed by Streel et al. (1987); Steemans (1989) and Steemans & Brasseur (1999). Microfossils often have the benefit to generate a fair amount of empirical data, useful to measure proxies (Simmons et al. 2015), but unfortunately, due to either intense metamorphic alternations and an overall poor preservation within our samples from a marine setting, a correlation with the pre-defined spore zonations from several locations within the Éislek region turned out to be non-conclusive for the Réideschbaach site. Macrofossils might thus far encompass the only suitable group of fossils, to define biozonations within this setting. However, when compared to microfossils, their abundance in all the strata from the Our and Kautenbach-Troisvierges Formations are a lot scarcer and altogether more fragmentary. Furthermore we find the majority of all macrofossils to be dissolved, consisting primarily of their solidified inner casts or imprints of hard-shelled (biomineralized) exoskeletons. This makes it very difficult to assign any macrofossil taxon as a high-resolution biostratigraphical marker for the Lower Devonian of the region.

When following the trilobite biostratigraphy and assigning an Early Emsian (relative) age to the Réideschbaach site, it might equally be interesting to take a closer look at the geological map drawn by Lunkenheimer (1989). In this geological map (scale 1:10.000) we observe that two distinct lithological entities were defined for the Réideschbaach-Fél valleys (Annex IV). Along the Réideschbaach valley we find the predominant occurrence of the so-called 'Siltstein Tonschiefer-Wechselfolge' (STW), loosely translated as the 'Siltstone Shale Alternating Sequence' in the north and the 'Obere Tonschiefer Abfolge' (OTA), translated as the 'Upper shale sequence' in the south (Fél valley). Though the boundary between both lithological entities is clearly defined upon the map (Lunkenheimer 1989: 166), the transition zone within the Fél Valley is rather vague as a result of the absence of continuous outcrops. However we must bare in mind that based on the description by Lunkenheimer, the boundary was not defined by lithological changes, but rather by the occurrence of the brachiopod: *Athyris undata* (Defrance, 1828) for the 'Siltstein Tonschiefer-Wechselfolge' (STW) and the Strophomenid (lamp shell) bivalve (*Proto*) *bojodouvillina taeniolata* (Sandeberger, 1855) for the 'Obere Tonschiefer Abfolge' (OTA), both serving as index fossils. The two lithological entities are compared to known stratigraphic entities in the German Eifel. The STW lithology is compared as an equivalent to the 'Eckfeld schichten' (Ulmen group) in the Eifel region, whereas the OTA is stratigraphically correlated to the 'Reudelsterz Schichten', also a part of the Ulmen group (Unterstufe - Lower Stage) within the German Eifel (Meyer 1986: 48-51). Both lithological entities are assigned a lower to lowermost Emsian age (based on German biostratigraphy), with the STW probably comprising the Emsian-Pragian boundary according to Lunkenheimer.

4 Samples and observations

4.1 Samples and sampling method

With the aid of an excavator, a total of 5 trenches were dug within the alluvial plain of the Fél stream, in order to expose the original succession of strata below the alluvial debris (Annex I). Within the first trench (Fig. 1), a general dip of 23° SW for all the exposed layers was observed. However, the fact that the excavation took place on the alluvial plain caused some challenges during fieldwork as the trenches quickly started to fill up with groundwater pouring through the unconsolidated alluvium (alluvial debris) within seconds (Annex II). This caused two major problems during sampling, first of all: the limited time to extract original bedrock and secondly, the distribution of mud and dirt from the overlying debris on all the freshly excavated bedrock. The rain during the first days of fieldwork contributed to an increased and rapid filling of the newly dug out trenches, pushing us to sample as quickly as possible. However, over the following days, the rain washed away the mud and dirt on the excavated bedrock, allowing for easier observations during paleontological sampling. The only good trench, allowing us to reach the bedrock without having to dig several meters of debris, was located on the west side (near the Boschleed hillside) of the Fél valley, just next to the Fél stream itself. Other interesting places in the middle of the alluvial plain were topographically more elevated, which we deemed to be indicative of a more pronounced underlying occurrence of original bedrock. Unfortunately during several test digs, it turned out that these elevated mounds were just larger deposits of alluvial debris (terraces), without any underlying topographical changes in the bedrock. Within the western trench (near the Boschleed hillside), A total of 77 samples (1.0 - 2.0 kg) were taken over a section of circa 20 m with a 25 cm interval within trench nr. (I). The samples were given a code with prefix RB21 (Réideschbaach 2021) and a numerical value as suffix, indicative of the height within the profile. The first samples were taken on the southern side of the trench going up north (but sampling older deposits and thus going down chronostratigraphical timescale). As a result, sample (RB21)-19.75 represents the base (oldest rocks) within our profile and sample (RB21)-00.00, the youngest deposit. We managed to sample below and above the layers that generated the most macrofossil remains between samples RB21-14.00 and RB21-15.00. These specific layers (fossil pocket) were dug out laterally in order to gather additional fossil remains (Annex I: Fig. A). Only the levels at -19.50 m and -14.75 m could not be sampled in-situ, as a result of the bad sampling conditions discussed previously. The highly anticipated fossiliferous concretions, containing well preserved trilobites and associated fauna's were not discovered within the trench, but rather ex-situ upon the excavated piles of debris, and along the stream to the south of trench nr. (I). This leads us to believe that either their distribution is laterally and heterogeneously distributed throughout the bedrock strata, or that their presence is not included within the length of the sampled section, possibly covered by the thick alluvium south of trench nr. (I)). We did however retrieve some of the fossiliferous nodules within the banks downstream of the Fél. directly to the south of our sampled profile. We presume that, in-situ, these nodules could be stratigraphically situated slightly above the sampled profile (Trench I). Unfortunately, we were not permitted to dig out our trench as far as the bank of the Fél stream, as this was prohibited by law. Therefore, we assume that the fossiliferous layer should be found in close proximity between our trench and the Fél stream. The fact remains that thus far, we do not have any direct proof that the fossil-bearing concretions sampled and described previously by Basse & Franke (2006) and Basse et al. (2006) can be attributed to a specific layer within the sampled lithological profile.

4.2 Lithological observations

The most characteristic lithology for the Réideschbaach site is the occurrence of red fossiliferous concretions, containing well-preserved trilobites and associated fauna(s), referred to as the so-called 'Réideschbaach' Fossil Fauna. These concretions have been the main point of focus from a paleontological perspective, since they yielded a remarkably diversified and taphonomically well-preserved fauna as discussed earlier. Although we cannot place these concretions within our lithostratigraphical profile, we hypothesize that their ex-situ and scattered presence can be attributed to either the debris of the overlying alluvium, the top (and excavated) layer of bedrock, or the Fél stream bank (from which they were extracted manually). The red fossiliferous concretions contain high amounts of Fe^{2+} or Fe^{3+} oxides, have a mottled appearance and have a rather heavy specific weight when compared to the other surrounding lithologies. This allows them to be easily spotted within the piles of debris during fieldwork. The concretions constitute a somewhat coarser grained and mottled matrix containing an abundance of dissolved imprints of fossils, and a mix of what seems to be reworked or very poorly- or unsorted remains of fossilized fauna. The red fossiliferous concretions display well-developed micaceous crystals when we split them. The exterior of the concretions is characterized by a presumably weathered dark red to black Fe-oxide coating. We also tested if the concretions reacted to a 1 M HCl solution but no dissolution was observed, confirming the absence of calcareous contents.

The vast majority of all samples within our stratigraphic profile constitute a rather monotonous accumulation of pelites, characterized by an alternation between flaser and lenticular beddings (Fig. 3). Especially the top 15 meters can be considered as the deposit of a rather uniformous accumulation of grey to very light-green and heavily mottled (dark brown to ochre-coloured) fine grained siliciclastic sediments. Using the terminology for fine-grained sediments and rocks as proposed by Sintubin (2009), we prefer to use the term pelite instead of slate or shales. Prominent oxidation is macroscopically present on nearly all the samples and is clearly visible under an optical microscope as orange spots within the sediment grains (Fig. 4). These oxidation marks are indicative of intense weathering and/or chemical alteration of the sediments in a presumed post-depositional context. Porosity and its associated permeability, were not measured on the samples but usually for rather homogeneous deposits, they fall within the low side of the scales (Fraser 1935). Values typically range between < 5% for porosity and < 1 nD (nanodarcy) for permeability for similar lithologies (Goral et al. 2020). When looking at the fissility of the strata within the profile, we can say that it is developed, but rather poorly. In a pluri-centimetric to decimetric array of the exposed profile we found that the pelites tend to break in a rather conchoïdal way.

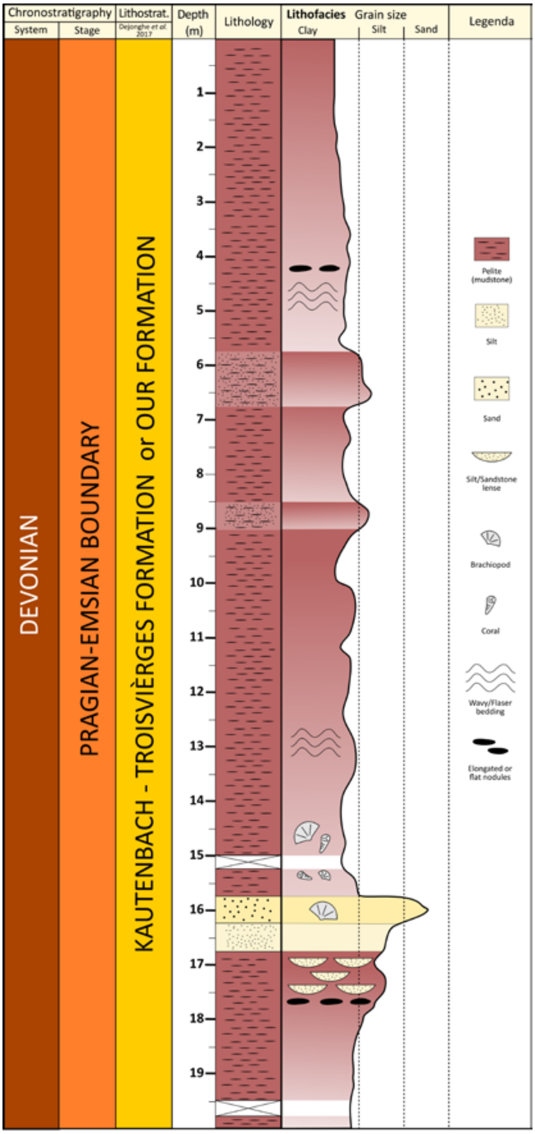

Fig. 3: Lithostratigraphic chart based upon the macroscopical observations of the Réideschbaach site.

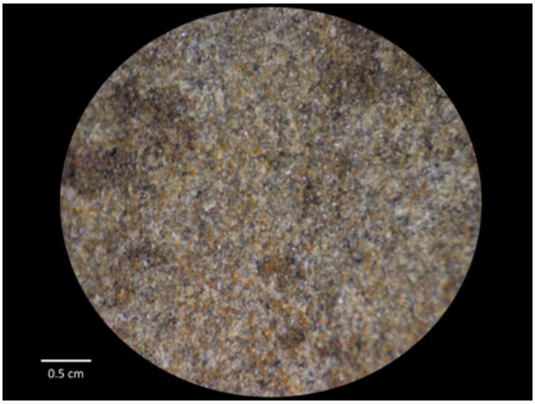

Fig. 4: Microscopical detail of sample RB21-7.50, showing the orange oxidation spots (orange) within the siltstone - pelite sample. This picture was made using a magnification of 3,2x. With the aid of an Euromex trinocular optical microscope. fitted with a Canon Eos 550D camera using a T2 ring adapter. Exposure time: 1/13 sec, ISO 3200, resolution 72 dpi.

Within the lower part of the lithostratigraphic profile (- 15.50 m to - 17.50 m), the pelite layers are characterized by the occurrence of flat (elongated) nodules with a thickness < 10 cm and alternated by fine to very-fine sandstone (62.5 µm - 250 µm) or silt (3.9 µm – 62.5 µm) lenses (based upon the Udden–Wentworth scale). These somewhat coarser layers range between 2 cm and 19 cm in thickness and manifest themselves over ca. 2 m of stratigraphic column, between -15.50 m

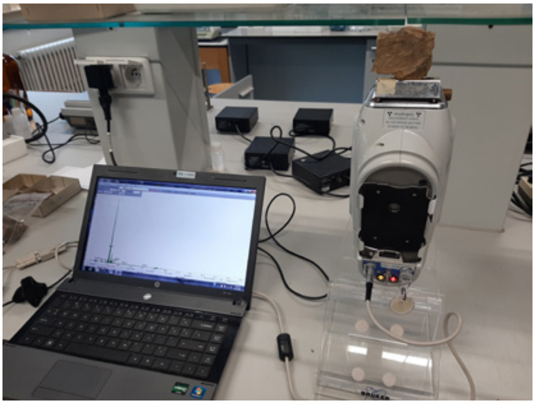

Fig. 5: Setup of the pXRF device at the 'Physico-chemical laboratory' of the geology department of the KU Leuven at Heverlee. The upright position allowed for an easy interchanging of samples.

and -17.50 m. Due to the fact that sampling was hindered by meteorological and hydrological conditions, it was impossible to check for any classic turbidite (Bouma) or tempestite sequences in the field. We did however notice the occurrence of alternations between lenticular and wavy beddings during sampling. Macrofossils were very rare in the succession. Amongst all of our in-situ samples we came across only a single pedicle valve of a chonetid brachiopod. The brachiopod mould is coated by an iron oxide (ochre coloured) patina and although slightly weathered, yet, ribs and sulcus are still visible. A fossiliferous pocket between 14.00 m and 15.00 m caught our attention when searching the debris piles and was continued laterally in trench (II), as discussed previously.

5 XRF analysis

5.1 p-XRF

All samples were measured at the 'Physico-chemical laboratory' of the geology dept. of KU-Leuven university in Heverlee (Belgium) on 7th november 2022. Prior to the measurements we had to remove moisture (water) within the samples. Therefore, humid samples were dried in a hot-air oven for one hour at 70°C and turned around every 20 minutes. After all the water content was extracted, the samples were thoroughly brushed to remove any excess dirt. In the lab the samples were broken with a hammer and chisel, in order to obtain a fresh test surface, to analyse the actual lithology rather than a weathered surface. As a pXRF device, we used a Bruker handheld Tracer III-SD with serial number: T351061 (manufacturing date 10/13/2010). The X-ray tube was used with an electrical potential of 40.00 kV and an electric current of 15.00 μA for the anode. The device was placed upon a plexiglass stand and connected to a laptop, allowing us to use the computer assisted activation via the S1PXRF software. This set-up, positioned in the upright state, allowed us to change samples without having to manipulate the actual device (Fig. 5). Samples were placed upon the sample platform and after every sample switch, the platform and beam aperture were cleaned. This static set-up and induced stability, allowed us to avoid additional deviations in measurements. For every sample we applied an X-ray exposure of 60 seconds. We used Bruker's pre-defined 'standard Mud Rock calibration', designed for our instrument, to arrive at element concentrations, using the S1PXRF software version 3.8.30 (by Bruker AXS Handheld inc.). The standard Mud Rock calibration of Bruker provides two different internal calibrations, labeled 'GL1' for major elements (Si, Al, Ti, etc.) and 'GL2' for minor elements (V, Cr, Ni, etc.). Despite the fact that calcium is a major element, the GL2 calibration for minor elements provided the most realistic results. A Bayesian deconvolution was applied as a correction method as well as a background escape (and pile-up) peak corrector to arrive at the final results.

Concerning the use of p-XRF as an analytical method, we should point out that, at the very best, the data can be considered as semi-quantitative (Bertin 1978; Lemiere 2018). In general, p-XRF yields quite large analytical errors, resulting from issues such as irregular samples surfaces, spectral overlap, orientations of specific minerals and sample heterogeneity, so we refrain from drawing any major conclusions based upon single anomalies or excursions within the datasets or spectra. Using an internal calibration instead of international reference standards, introduces even more uncertainty (Conrey et al. 2014). Furthermore, the applied instrument seems to have issues with the silicon (Si) detection, which is lower than expected. According to Lunkenhe-

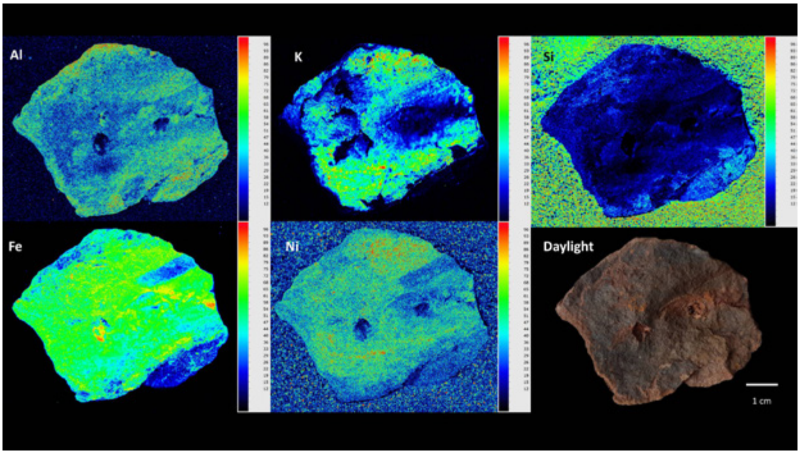

Fig. 6: XRF Mapping of the red fossiliferous concretions or nodules which contain the Réideschbaach fauna. The mapping was conducted with the aid of a Bruker M4 Tornado μ-XRF spectrometer. Notice the main presence of Aluminium (Al), Potassium (K) and Iron (Fe) within the concretion and the overall heterogeneous distribution of elements.

imers study, the silicon content within the concretions for example are clearly visible and well represented even though they are not quantified (Lunkenheimer 1989: 51). We should thus be careful not to focus or conclude too much merely based on the silicon contents.

Given the limitation of the analytical approach used, it is expedient to focus on trends in our dataset, instead of on quantitative values. Similarly, generally it is better to focus on element ratios instead of single elements (Piercey & Devine 2014). For example, silicon was therefore normalized over Al to determine the fluctuations between sand (typically containing a high Si content) and clay (consisting often of Al phyllosilicates).

5.2 μ-XRF

On the 6th march 2023, a μ-XRF mapping of the red fossiliferous concretions took place at the Analytical, Environmental and Geo- Chemistry (AMGC) lab of the Vrije Universiteit Brussel (VUB). Using a Bruker Tornado M4 benchtop surface scanner (Bruker nano GmbH, Berlin, Germany). This spectrometer is equipped with a Rhodium (Rh) tube as the X-ray source and two XFlash 430 Silicon Drift detectors, capable of elemental mapping at 25 μm resolution. A flat sample of the concretions was mapped (Fig. 6) with the aim of comparing it to the data of Lunkenheimer (1989). Although the mapping should not be considered as a quantitative distribution of elements, it gives insight into the distribution and occurrence of major and trace elements. The sample itself was chosen as the most representative piece for all other samples originating from the red fossiliferous concretion layer. This includes the presence of a fossil mould, macroscopic discoloration (mottling) upon the surface, and a part of the weathered exterior of the concretion.

5.3 Major and minor elemental compositions

The μ-XRF mapping (Fig. 6) shows an equal abundance of potassium (K) and Aluminium (Al) elements, as to be expected within this micageous matrix. This is in accordance with the data gathered by Lunkenheimer (1989), who observed the occurrence of chlorites and Illites, rich in Al and K, respectively, within the red fossiliferous concretions. Notable, when compared to Lunkenheimer's data, is the absence, or very low undetectable concentrations, of silicon (Si) within the concretion as well as the presence of Nickel (Ni) and Strontium (Sr). As expected, there is a prominent occurrence of Fe within the concretion, with higher concentrations around the macrofossil moulds of the analysed specimen. The heterogeneous distribution of elements in the μ-XRF heatmap shows that the formation of these concretions are suggesting a complex process including gradual enrichment and precipitation of elements during an intense process of concretion formation.

As expected for pelites (Forshaw & Pattison 2022), our p-XRF analyses of the stratigraphically collected rock samples revealed that the most abundant measured elements are Al, and Fe, with minor contributions of Si, manganese (Mn) and K. A ratio that is useful for a lithological characterization, is the ratio of Si over Al , as it generally reflects changes in grain sizes. Indeed, in our record, more sandy intervals (e.g. -15.75 m to -16.75 m) are generally characterized by a high Si/Al ratio (see: supplements), whereas a low Si/Al corresponds to more clayey intervals. Given this, the p-XRF-based Si/Al profile was used to estimate subtle grain size variation through the record, to complement initial field-observations during logging and to refine our lithological profile. The ratio of zirconium (Zr) over aluminum (Al), often used as an indirect proxy for grain size as well (Bahr et al. 2014), shows a comparable trend. Zirconium is typically regarded as a weathering product from a continental setting. The sand likely originated from the Old Red Sandstone continent or nearby caledonian land masses in the region, (see: 3.2 geological context). Heavy minerals are enriched in zirconium and titanium (Fralick & Kronberg 1997), which are typically presented in a relatively coarse grained fraction, resulting in high Zr/Al and Ti/Al values (Schnetger et al. 2000). Indeed, the Ti/Al ratio also shows a very similar trend (Fig. 7). Within our log, these higher values in Ti/Al and Zr/ Al, are clearly visible at the sandstone lenses that occur at the basal part of our profile (-15 - 16 m; Fig. 7). The observed increased grain size resulted either directly from a riverine input of coarse-grained siliciclastics or indirectly through turbidites in a deeper open marine setting. Elements reflecting clay content, such as K and Al show an opposite trend in our dataset. Given the striking similarities between the Si/Al, Ti/Al and Zr/Al, any patterns in these ratios might be mainly driven by variations in % Al, given the normalization over Al.

We observe a seemingly cyclic pattern within the Zr/Al and Ti/Al profiles with lower values at the base of the succession, between -15 and -10 m, and between -3 and 0, potentially indicative of a sequence stratigraphic signal. The intervals with smaller grainsizes, indicated by lower Zr/Al and Ti/Al values, possibly reflect decreasing proximity to a coastline, i.e. a marine transgression. Also the Ca %, likely reflecting varying carbonate content, seems to show an almost cyclic signal, with two rapid jumps to relatively high values (1.0 - 1.8 %), at -19 m and at -9 m, each time followed by gradually decreasing values, reaching stable minima of 0.8 - 1.1 % between -12.5 m and -10.25 m and between -3.0 and 0.0 m (Fig. 7). In this sequence stratigraphic interpretation, the coarser, Ca-rich intervals would reflect regressions or lowstands, the sharp transition to finer-grained, Ca-poor lithologies would reflect transgressions. These possible sea level changes observed in the Si/Al, Zr/Al, Ti/Al and Ca% records could be linked to either tectonic activity or changes in the regional or eustatic sea-level. Notably, the fossil pocket between 15 m and 14 m occurs at the base of such a transgression. The 'Réideschbaach' fossil fauna (the red fossiliferous nodules), likely situated just above the sampled interval, possibly reflects the base of the overlying sequence.

The Rb/K ratio is considered a proxy for chemical weathering or for the input of chemically weathered material (Lo et al. 2017). Within the Reidersbach succession, higher Rb/K ratios are likely indicative of the deposition of chemical weathering products coming from the detrital influx of the old red sandstone continent or similar caledonian land masses. Within our dataset (Fig. 8), the Réideschbaach fossil fauna concretions possess significantly higher values when compared to the other strata, which show a relatively stable baseline with the exception of individual samples around -15 m and -18,50 m, corresponding to the sandy interval with fossil pockets. Between these two excursions the dataset seems to be scattered a bit more, possibly resulting from variations in lithology (a potassium (K) depletion as main driver of decrease in clay content). The high values measured within the concretions, suggest a deposition or formation of the concretions, linked to the direct or indirect input of weathering products.

If we want to reconstruct the depositional environments, the vanadium (V) and chromium (Cr) ratio can be used to identify fluctuations in the oxygen content of the seawater. According to (Hatch & Leventhal, 1992; Jones & Manning, 1994), higher V/Cr ratios equals more anoxic conditions. In literature, the following values are defined > 4.25 = anoxic, 2.00 - 4.25 = suboxic; <2.00 = oxic. Within our record (Fig. 8), nearly all of our in situ samples (with the exception of sample RB21-19.25) fall below 2.00, which suggests that we are dealing with an oxic depositional environment. While there seems to be some slight variations within our data, the V/Cr values remain low. Given that neither the RFF nodules nor the samples around the fossiliferous pocket (RB21-14.00 - RB21-15.00) show any increase in V/Cr values, the fossil assemblages at the Réideschbaach site likely do not reflect mass mortality events as a result of anoxic conditions. The ratios of manganese (Mn) and molybdenum (Mo) over aluminum (Al), both indicative of pore-water oxygenation, confirm this. Divalent manganese Mn(II) is extremely mobile during early diagenesis in reduced marine sediments and tri- and tetravalent manganese (Mn (III - IV)) are often fixed in the oxidizing environment (Thomson et al. 1995; Schnetger et al. 2000; Roy 2006; Tribovillard et al. 2006; Rodrígues-Tovar & Reolid 2013). A lower Mn/Al ratio is therefore suggestive of more reducing pore-waters. All values below the average European shale of 0.01, could reflect less oxygenated bottom waters (Osborne et al. 2017). The high values (>0.02) of Mn/Al in our record (Fig. 8) are therefore characteristic of sediments deposited in oxygenated bottom waters. (Calvert & Pedersen, 1993; Schnetger et al. 2000). A very similar trend is found in the record of Molybdenum (Mo) over Aluminium (Al) (Fig. 9). A high Mo/Al ratio (> 0.15) calculated by Wedepohl (1971; 1991) and Tribovillard et al. (2006), would corresponds to more reducing sediments whereas a low Mo/Al ratio measures up to less oxic sediments (Hennekam et al. 2020). Within the Réideschbaach record, Mo/Al values generally remain below 0.005. Reviewing the data of the Mn/Al and Mo/Al ratios we can carefully say that the record is characterized by comparatively very low values for the shales, which do not come close to anoxic conditions.

From a paleontological perspective the ratio of Phosphorus (P) over Aluminium (Al) shows an intriguing signal in the Réideschbaach record (Fig. 9). An increase in Phosphorus content within sediments, reflects high bioproductivity connected to the enhanced burial of organic matter. Higher P/Al ratios therefore reflect higher production of organic material within an ecosystem over a given time. It is no surprise that the highest systematic values correspond to the fossiliferous pocket in samples RB21-15.00 to RB21-15,75. Similarly, a higher ratio of Barium (Ba) over Al also corresponds to a higher productivity (Wignall & Myers 1988; Stoll & Schrag 2001; Rodrígues-Tovar & Reolid 2013). Indeed, the Ba/Al ratio of the Reidersbach record shows a similar trend (Fig. 9), indicative of a general high productivity environment.

The p-XRF data turned out to contain some delicate trends. These trends should be carefully interpreted as proxies for indirect changes in the environment or secondary effects of diagenesis (or low grade metamorphism) in this particular case. We observe that the fossil-rich pocket (or faunal bed) between RB21-14.50 and RB21-16.00 is characterized by an increase in bio productivity and an increase in weathering products. We can therefore suggest a structural pattern within the acquired data clearly manifests itself in multiple groups of element ratios. This increase in weathering products might serve as a possible source of nutrients for the fossil organisms we found in this section of the profile. Throughout all the measured data, the consistent excursions found between samples RB21-14.50 and RB21-16.00 are evident when compared to what we observed macroscopically in-siu. However, our measurements show two other fairly consistent excursions that have been documented as well. These excursions between RB21-5.50 and RB21-6.75 as well as RB21-8.00 and RB21-9.00 also seem to be rather constant, nonetheless they were classified as being part of a rather monotonous series of pelites in our profile. The values in terms of bioproductivity, oxygen content seem to indicate a higher level of biological activity, contrary to the quantitatively low occurrence of macrofossil remains. However we are sure that some of the fossils that were collected during fieldwork upon the ex-situ piles of debris might actually find their origin within these layers.

6 Conclusions

Given the recently described species of Devonian trilobites and associated fauna as presented within the other articles of this Ferrantia volume, the Réideschbaach site is considered a site with great paleontological significance. From a lithostratigraphic perspective, the succession of sampled strata could either belong to the Our Formation or the Kautenbach-Troisvierges Formation as there is no boundary defined between them. Though no absolute dating has been established, an early Emsian age was proposed, based on the macrofossil remains. It would however be safer to say that in

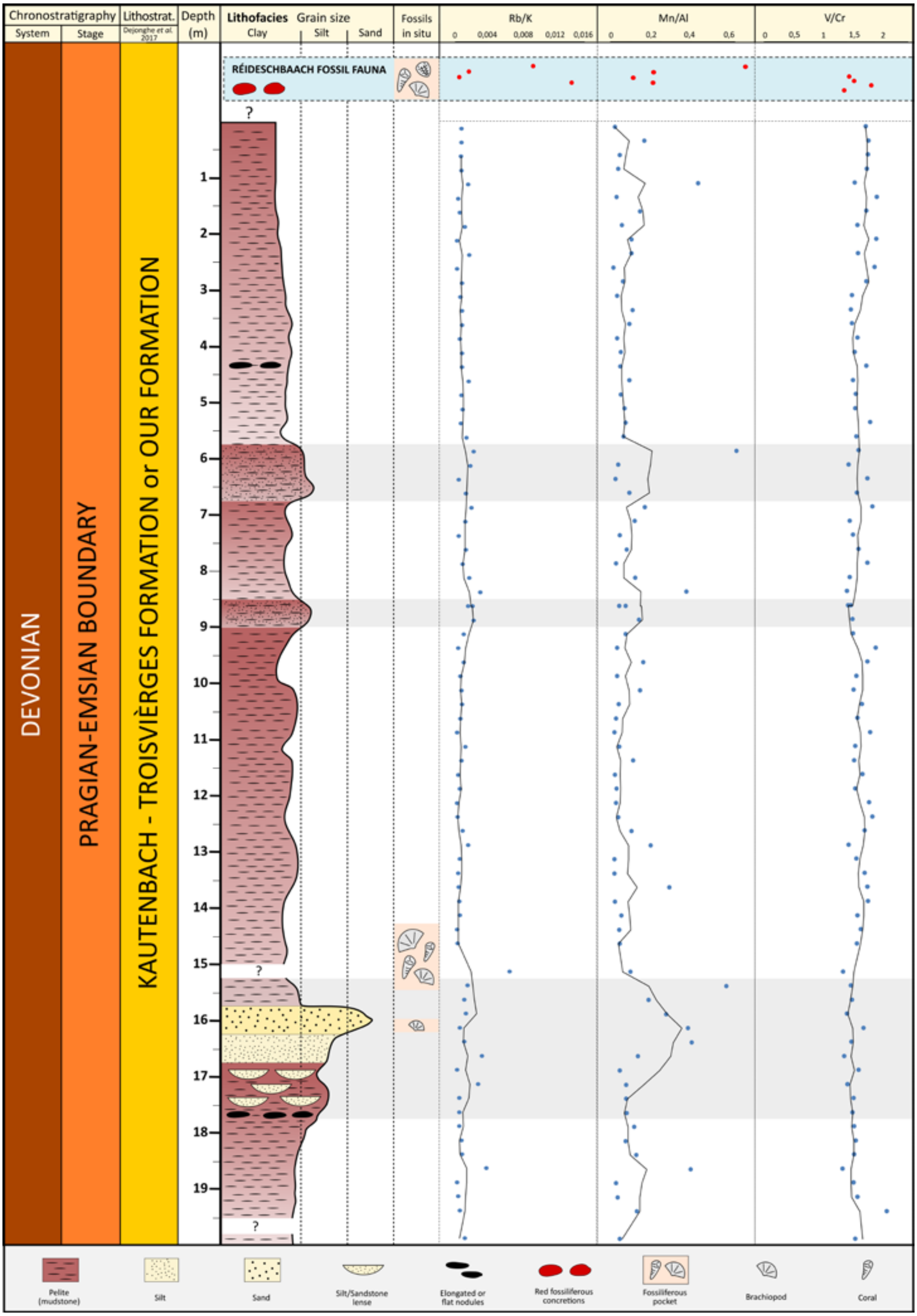

Fig. 7: Lithololological log combined with the graphs and results of several element ratios measured with pXRF. The most important trends and variations are shaded.

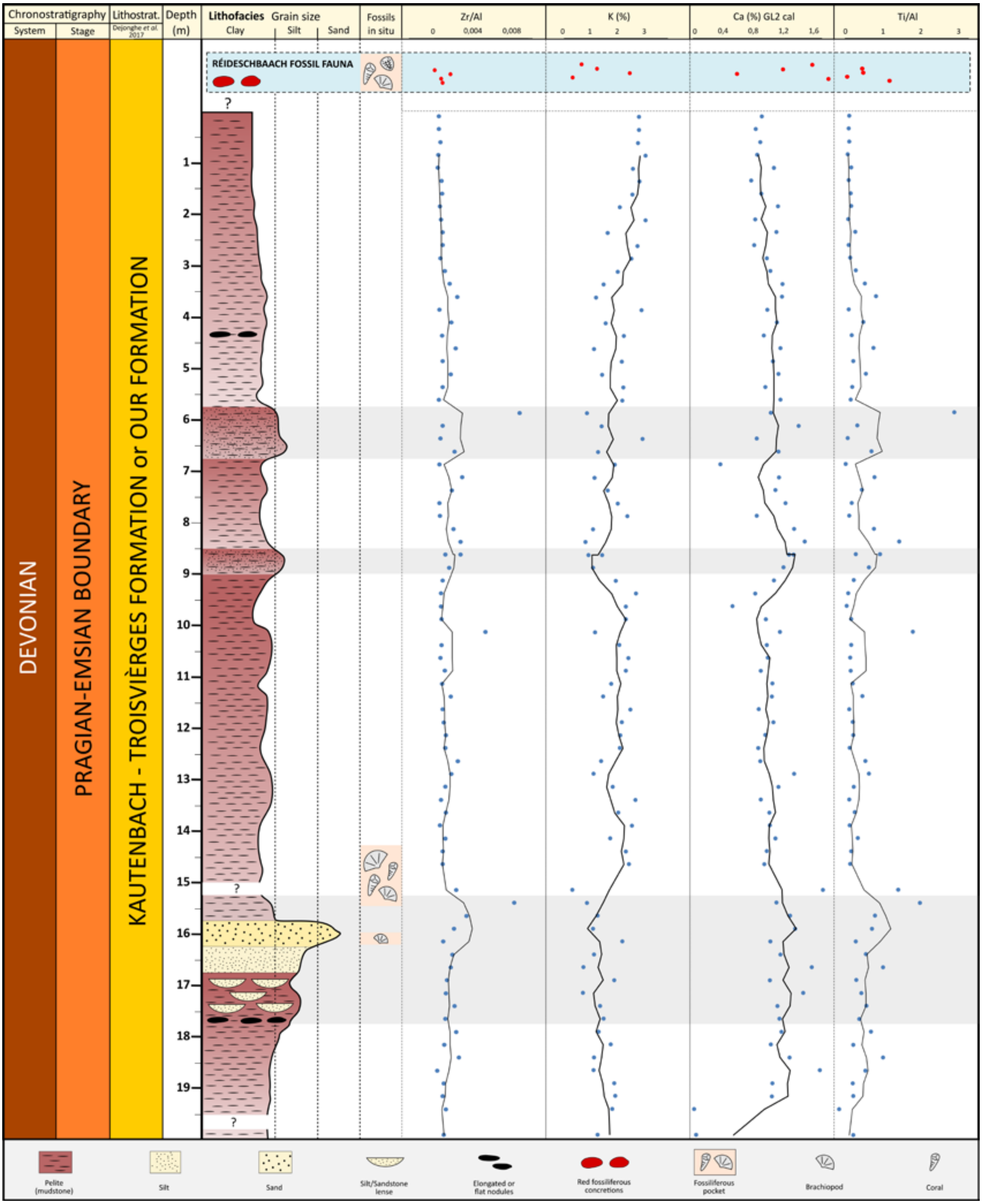

Fig. 8: Combined graphs of the V/Cr and Mn/Al ratios within the tested samples. These graphs provide an overview of the redox conditions within the sampled strata of the Réideschbaach site. All trend lines represent a moving average with a period (k) = 4, as there are 4 samples per meter.

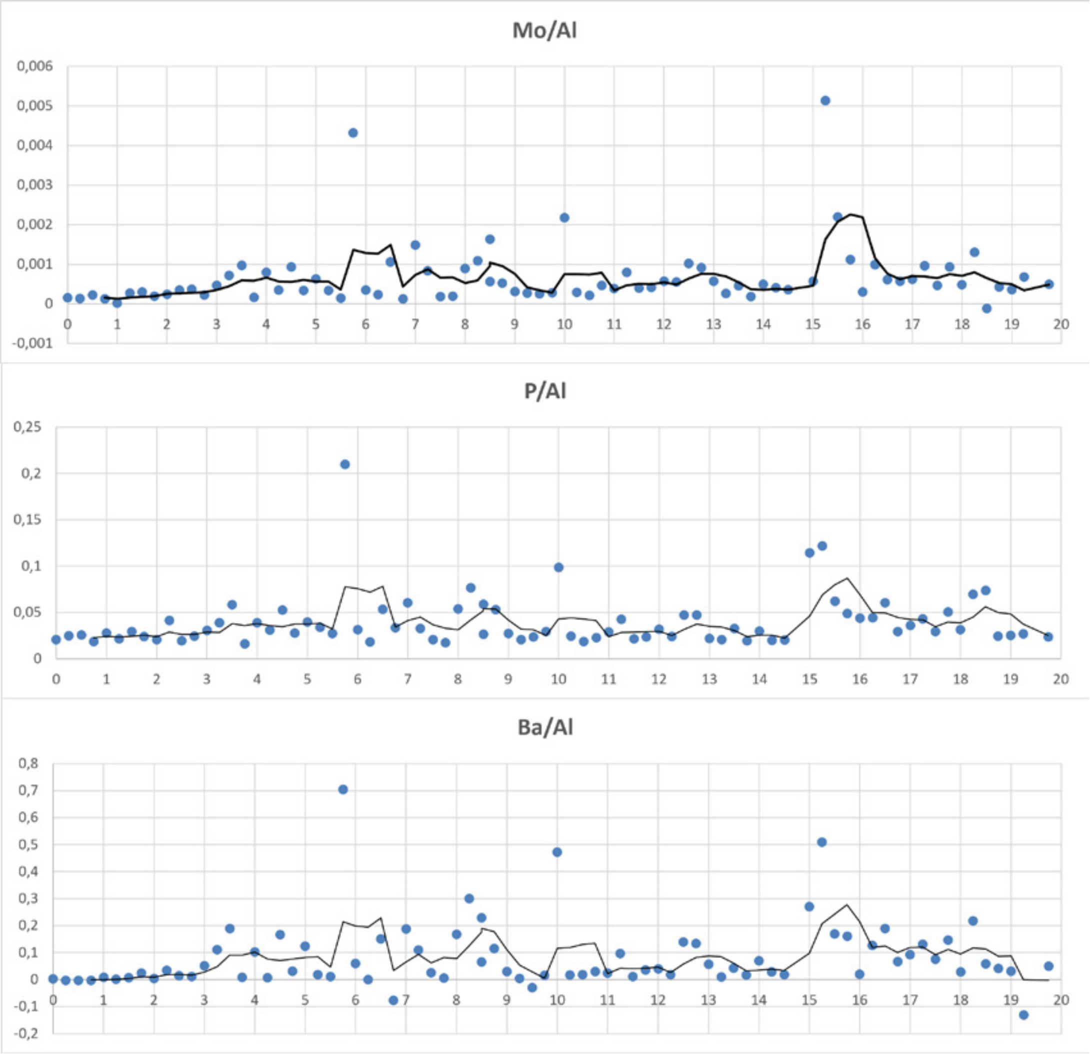

Fig. 9: Combined graphs of the Mo/Al, P/Al and Ba/Al ratios from the Réideschbaach samples. In almost 20 m of sampled strata we see clear trends in the influx of organic material and bioproductivity.

a chronostratigraphic framework, we are dealing with a presumed Pragian-Emsian boundary. The strata from the Réideschbaach site are not easily accessible, which makes it difficult to study them in-situ without the aid of mechanical excavation equipment. Fieldwork within the alluvial plain was the only option to obtain an unweathered succession of strata, but not the ideal setting for sampling or working in general as a result of the continuous infiltration of groundwater and jurisdictional restrictions. Our research shows that the geology is vastly influenced by low grade metamorphism during the variscan orogeny, resulting in the deformation of strata and its macrofossil contents. Geochemical alterations such as dissolution, precipitation and recrystallization are an ubiquitous part of the changes that all the concerned strata endured over time. As a result of this, the majority of all the collected macrofossils represent imprints, inner casts (moulds) of the once hard-shelled (biomineralized) exoskeletons. Although the macrofossil remains are scarce outside of the red fossiliferous concretion layer, p-XRF data shows that the marine environment must have been very hospitable to accommodate life. The Réideschbaach strata are representative of a stable ecological environment with no sign of oxygen depletion throughout the studied succession or in the level with the 'Réideschbaach' Fossil Fauna. The continuous influx of nutrient rich siliciclastic sediments must have been a good primary source of nutrients for marine organisms. This might especially be true for the Réideschbaach fossil fauna inside the red fossiliferous concretions, showing high Rb/K values demonstrating a high influx of chemically weathered material which might act as a source of nutrients into this particular layer. Our data shows that the lithology associated with these concretions differs from the surrounding strata. We might speculate that this is the result of a sequential event as trended within our Si/Al, Zr/Al, Ti/Al and %Ca profiles. A higher influx of siliciclastic material (weathering products) in combination with a climatological or tectonic event, might have triggered or enhanced a more suitable burial and fossilisation mode of the ecosystem at that time. However this remains highly speculative. The µ-XRF mapping shows us that the red fossiliferous concretions, containing the Réideschbaach fauna, are not composed of silicon, but are in fact a somewhat coarser potassium and aluminum (pelite) concretions. As to this point, we are still uncertain of its origins. In future research, the exact stratigraphic position of the red fossiliferous concretion bed still needs to be confirmed, so it can be linked to the lithological profile that was documented.

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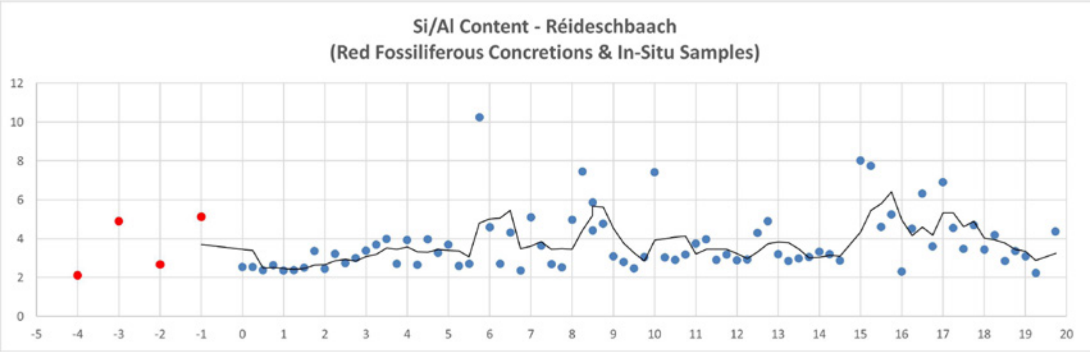
Supplementary data and annexes



Si/ Al graph
X-axis: Sample N° (sample -5 to -1 = Red Fossiliferous Concretions) - Y-Axis: Measured values

Annex I: A) Main trench (I) dug out along the course of the Fél stream. A secondary trench (II) was dug out along the side, parallel to the orientation of the underlying strata, to laterally continue the fossiliferous pocket that occurred around RB21-14,00 - RB21-15,00. **B)** The top layer of the third trench (III) was removed in an attempt to reach the underlying strata. **C)** A fourth trench (IV) was dug alongside the banks of the Fél stream in order to reach possible accumulations of the red fossiliferous beds that were previously found within the banks of the stream. **D)** NW view along the main trench (I). **E)** SE view on the digging of trench (III). **F)** SE facing view of the Fél alluvial plain.

ANNEX II: A) Digging the fifth trench (V) on a higher part of the alluvial plain. Notice the colour shift in lithologies within the deposited alluvium. Unfortunately, no original strata were reached as a result of rising groundwater and vast deposits of unconsolidated alluvium. **B)** Main trench (I) freshly dug out. **C)** After a few moments groundwater was seeping into the main trench (I). **D)** Excavator seperating the original bedrock from the alluvium. **E)** Sample bags along the freshly excavated original bedrocks within the primary trench (I). **F)** Sample bags along the side of the main trench sampling every 25 cm. **G)** Samples had to be recorded quickly and collected to prevent the rising groundwater from washing them away. **H)** Looking for the typical red fossiliferous concretions along the banks of the Fél stream.

ANNEX III: A part of the participants of the Réideschbaach field campaign on 6th november 2021. From left to right: Ivo Kesseleer (NL), Allart van Viersen (NL), Kevin Nolis (BE), Markus Poschmann (DE), Christian Franke (LUX), Johan Vellekoop (BE-NL), Ben Thuy (DE-LUX), Frederik Lerouge (BE), Anjin Thill (LUX), Yann Gillen (LUX), Charel Rollinger (LUX). Not present in the picture: Anthonie Hellemond (BE), Peter Müller (DE), Martin Müller (DE), Nico Meyer (LUX - excavator operator).

Bivalvia & Rostroconchia

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Schlüsselwörter: Réideschbaach, Unterdevon, Bivalven, Emsium, Rostroconchen.

Zusammenfassung

Die Bivalven und Rostroconchen vom Réideschbaach bestätigen ein unteremsisches Alter. Nur auf das Siegenium beschränkte Spezies konnten nicht nachgewiesen werden. Die vorgefundenen Arten deuten auf einen marinen Lebensraum im küstennahen Flachwasserbereich. Der einzige Fund einer Rostroconchia ist sehr wahrscheinlich ein Vertreter der Typus-Art der Gattung *Hoareicardia*. Ihr Vorkommen bereits im unteren Unter-Emsium kann damit als gesichert angesehen werden.

Keywords: Réideschbaach, Lower Devonian, Bivalves, Emsian, Rostroconchia.

Abstract

The bivalves from the Réideschbaach confirm a Lower Emsian age. Species restricted to the Siegenian could not be detected. The species found indicate a marine habitat in the coastal shallow water area. The only find of a Rostroconchia is very probably a representative of the type species of the genus *Hoareicardia*. Its occurrence in the lower Lower Emsian can therefore be regarded as certain.

Mots clés: Réideschbaach, Dévonien inférieur, bivalves, Emsien, rostroconches.

Résumé

Les bivalves du Réideschbaach confirment un âge Emsien inférieur. Seules des espèces limitées au Siégenien n'ont pas pu être mises en évidence. Les espèces trouvées indiquent un habitat marin dans les eaux peu profondes proches de la côte. La seule découverte d'une Rostroconchia est très probablement un représentant de l'espèce type du genre *Hoareicardia*. Sa présence dès l'Emsien inférieur peut donc être considérée comme certaine.

1 Abkürzungen und Definitionen

L = gesamte Klappenlänge.
H = größte Klappenhöhe.
dk = doppelklappiges Exemplar.
rK = rechte Klappe.
lK = linke Klappe.
Stk = Steinkern.

Schabdr = Schalen-Abdruck (negativ).

MnhnL - Sammlung des Musée national d´histoire naturelle Luxembourg.

Réideschbaach-Schichten – diese Bezeichnung wird hier als informeller Begriff für die Siltsteine mit Konkretionen und quarzitischen Sandsteine vom Réideschbaach benutzt. Sie entsprechen dem unteren Teil der Oberen Tonschiefer-Abfolge bei Lunkenheimer (Basse & Franke 2006: 9, Tab. 1).

REI 1 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS-Daten:

49°52'49.42''N, 6°00'27.05'' O.

REI 2 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS-Daten:

49°52'54.81''N, 6°00'19.40'' O.

REI 5 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS-Daten:

49°52'47.96''N, 6°00'36.55'' O.

2 Paläontologischer Teil

2.1 Bivalvia

Nuculoidea sp.

Material: 1 nicht näher bestimmbares Stk-Fragment dK; REI1.

Palaeoneilo candida (Kegel, 1913)

Material: 1 Stk-Fragment rK, Taf. 1:1.

Beschreibung und Diskussion: siehe Kegel (1913: 82-83, Taf. 4 Fig. 9), Eichele (2014: 27, Taf. 3 Fig. 7, 8)

Morphologie: vor dem Wirbel 21, nach dem Wirbel 6 Zähne.

Vorkommen: Oberes Siegenium bis einschließlich unteres Unter-Emsium.

Tolmaia lineata erecta (Dahmer, 1936)

Material: 1 Stk rK, 1 Stk-Fragment lK mit Schabdr, Taf. 1: 2.

Beschreibung und Diskussion: siehe Dahmer (1936: 6); Maillieux (1937: 39-41, Taf. 2 Fig. 1, 2, 2a); Eichele (2014: 57 Taf. 12 Fig. 2-4, Taf. 15 Fig. 1).

Vorkommen: Mittleres Siegenium bis einschließlich unteres Unter-Emsium.

Cornellites costatus (Goldfuss, 1835)

Material: 4 Stk lK mit Schabdr, Taf. 1: 3.

Beschreibung und Diskussion: siehe Frech (1891: 81-83, Taf. 8 Fig. 2, Taf. 9 Fig. 4-8); Eichele (2014: 48-49, Taf. 8 Fig. 2-7).

Vorkommen: Unter-Emsium bis einschließlich mittleres Ober-Emsium.

Leptodesma (*Leiopteria*) *pseudolamellosa* Mauz, 1933

Material: 1 Stk lK, 1 Schabdr-Fragment, Taf. 1: 4, 5.

Beschreibung und Diskussion: siehe Mauz (1933: 283-284). Diese Spezies unterscheidet sich durch die gröbere und weitmaschigere Krenulierung von *L.* (*L.*) *crenatolamellosa* (Sandberger & Sandberger 1854) und *L.* (*L.*) *pseudolaevis* (Oehlert, 1882).

Vorkommen: Unteres bis einschließlich mittleres Unter-Emsium.

Limoptera semiradiata Frech, 1891

Material: 1 Stk lK mit Schabdr., Taf. 1: 6.

Beschreibung und Diskussion: Frech (1891: 65-66); Maillieux (1932: 10-11); Dahmer (1948: 122-123); Franke (2016: 37-39).

Vorkommen: Oberes Siegenium? bis einschließlich mittleres Ober-Emsium.

Pterinopecten (*Pterinopecten*) *follmanni* (Frech, 1891)

Material: 1 Stk mit Schabdr lK, 1 Stk-Fragment mit Schabdr, Taf. 2: 1a, b.

Beschreibung und Diskussion: Frech (1891: 29); Maillieux (1936: 107-108).

Vorkommen: Oberes Siegenium bis einschließlich oberes Unter-Emsium.

Goniomorpha sp. aff. *G. rhenana* (Beushausen, 1895)

Material: 1 Stk lK, 1 Stk rK, Taf. 2: 2.

Beschreibung und Diskussion: Ein skulpturloser Steinkern mit Bewuchs von Epöken. Ohne Muster der Schalen-Skulptur ist keine nähere spezifische Zuweisung sinnvoll.

Goniomorpha stuertzi (Beushausen, 1895)

Material: 1 Stk mit Schabdr rK, 1 Stk-Fragment lK, Taf. 2: 4a-c.

Beschreibung und Diskussion: Beushausen (1895: 210-211).

Vokommen: unteres Unter-Emsium bis mittleres Ober-Emsium.

Goniomorpha sp.

Material: 1 nicht näher bestimmbares Stk-Fragment lK, Taf.2 : 3.

Cypricardinia crenistria (Sandberger & Sandberger, 1854)

Material: 2 Stk rK, 1 Stk-Fragment rK, 1 Schabdr rK, 1 Stk lK, Taf. 1: 7-9.

Beschreibung und Diskussion: Beushausen (1895: 178); Maillieux (1932: 213-215). Ein direkter Vergleich mit unserem reichhaltigen Material aus den oberemsischen Wiltz-Schichten hat gezeigt, dass keine wesentlichen Unterschiede zu den Stücken aus den Réideschbaach-Schichten bestehen, die eine artliche Abtrennung rechtfertigen würden. Bei den älteren, unteremsischen Exemplaren scheinen lediglich die Klappen etwas gewölbter, das spezifische Merkmal der feinen Spikulae zwischen den Kommarginal-Rippen ist gleich.

Das beschriebene und abgebildete Material zu *Cypricardinia mediorhenana* Fuchs, 1915 (siehe dort: 57-58, Taf. 11 Fig. 9-11) scheint verdrückt und unvollständig zu sein. Trotzdem ist ersichtlich, dass es sich hier um eine andere Art handelt. Sie besitzt im Gegensatz zu *C. crenistria* weniger Rippen und eine andere Umrissform.

Vorkommen: Unterstes Unter-Emsium bis einschließlich mittleres Ober-Emsium.

Grammysia sp. aff. *G. ovata* Sandberger & Sandberger, 1854

Material: 1 Stk-Fragment lK, aufgrund der schlechten Beschreibung nicht näher bestimmbar. Taf. 2: 5.

Beschreibung und Diskussion: für *G. ovata* siehe Beushausen (1895: 240-242, Taf. 19 Fig. 1-3, Taf. 22 Fig. 2).

Vorkommen: Mittleres Siegenium bis oberes Unter-Emsium.

2.2 Rostroconchia

Hoareicardia Rogalla & Amler, 2006

Typus-Art: *Pleurorhyncus cuneus* Conrad, 1840 (sic!).

Hoareicardia cuneus (Conrad, 1840)

Taf. ii: 6a-d.

*1840 *Pleurorhyncus cuneus* Conrad. -Third Ann. Report: 206-207.

parte1853 *Cardium crenatum* Steininger. – Geogn. Beschr. Eifel S. 51, Taf. 3 Fig. 5a, b. non Taf. 3 Fig. 4a, b.

parte 1895 *Conocardium rhenanum* n. sp. Beushausen. – Lamellibranchiata, S. 402-405, Taf. 30 Fig. 6, 6a-d, non Taf. 30 Fig. 5, 5a-b, 7, 7a, 8.

cum syn. Rogalla & Amler 2006: 262-165.

Material: 1 Stk-Fragment, Taf. 2: 6a-d.

Morphologie: Gehäuse hippocardiin, Schnauzenumriss gerade alaeform bis triangular, Länge 19,5 mm, Umriss der Schnauzenöffnung langgestreckt, abgerundet kegelförmig, Rostrum abgebrochen, Flügel und mediane Klappenregion mäßig aufgebläht, auf den Flügeln jeweils 8 Rippen, auf den medianen Klappenregionen jeweils 6 Rippen; Ausprägung der Rostralfäche in ventraler Aufsicht flach

1

2

3

4

5

6

7

8

9

konkav. Rostralfläche mit jeweils ca. 8 gleichförmigen Rippen.

Diskussion: Eine große morphologische Übereinstimmung unseres Stückes findet sich mit Beushausens Abbildung (1895: Taf. 30 Fig. 6, 6a-d) zu seiner Art *Conocardium rhenanum*. Nach den gründlichen Recherchen von Schröder-Rogalla (2005) ist *C. rhenanum* in Teilen, und eben genau in diesem Stück, als ein jüngeres subjektives Synonym von *H. cuneus* anzusehen.

Wie Rogalla & Amler (2007: 61) treffend befinden, basiert das Taxon *Conocardium rhenanum* Beushausen, 1895, auf gänzlich unzureichendem Material und sollte nur auf das Typus-Material beschränkt bleiben. Das Typus-Material stammt aus den oberemsischen Laubach-Schichten in der Umgebung von Koblenz. Eichele (2014: 121, Taf. 35 Fig. 6-10) dokumentiert einige Fundstücke aus dem Mittelrhein-Gebiet, vom mittleren Unter-Emsium bis zum unteren Ober-Emsium unter der Bezeichnung *Hippocardia rhenana* (Beushausen, 1895).

Die von Steiniger (1853: 51) aufgestellte Art *Cardium crenatum* ist nach den Untersuchungen von Schröder-Rogalla (2005: 166) ebenfalls in Teilen als jüngeres subjektives Synonym von *Hoareicardia cuneus* anzusprechen. Dies betrifft das bei Steininger abgebildete Stück von Hermeskeil (1853: Taf 3, Fig. 5a, 5b). Da die genaue Fundstelle nicht bekannt ist, kann davon ausgegangen werden, dass das Exemplar mindestens unteres unteremsisches Alter haben muss. Das Stück aus Daleiden von Steininger (1853: Taf. 3 Fig. 4a, 4b) schließt Schröder-Rogalla aus. Das bedeutet, dass der Name *crenatum* erhalten bleiben müsste, wie bereits Eichele (2014: 122) einräumte. Seine als *Hippocardia crenata* (Steininger, 1853) abgebildeten oberemsischen Exemplare aus dem Mittelrhein-Gebiet (ibidem, Taf. 35 Fig. 11-16) lassen sich gut mit unserem oberemsischen Material aus Daleiden und Hosingen vergleichen. Ihre Gehäuseform wirkt kompakter durch die wesentlich geringere Länge im Vergleich zur Höhe. Der Schnauzenumriss ist konkav alaeforme. Die Rostralfläche lässt sich allerdings kaum zweifelsfrei von *Hoareicardia cuneus* abgrenzen. Uns liegen jedoch nur drei Stücke vor, so dass eine endgültige Aussage noch nicht getroffen werden kann.

Tafel 1

1. *Palaeoneilo candida* (Kegel, 1913), Steinkern einer rechten Klappe, Lateral-Ansicht, x 2,8, Länge 8mm; MnhnL EIA 516. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

2. *Tolmaia lineata erecta* (Dahmer, 1936), Steinkern einer linken Klappe, Lateral-Ansicht, x 1,5, Länge 33mm; MnhnL EIA 519. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

3. *Cornellites costatus* (Goldfuss, 1835), Steinkern einer linken Klappe, Lateral-Ansicht, x 1, Höhe 39mm; MnhnL EIA 409. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

4. *Leptodesma* (*Leiopteria pseudolamellosa*) Mauz, 1933, Steinkern einer linken Klappe, Lateral-Ansicht, x 1,5, Länge 19mm; MnhnL EIA 317. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 5) bei Heiderscheid, Oesling, Luxemburg.

5. *Leptodesma* (*Leiopteria pseudolamellosa*) Mauz, 1933, Steinkern, Außen-Abdruck zum Verdeutlichen der Krenulierung, Fragment einer linken Klappe, x 1,6. Länge 15mm; MnhnL EIA 421. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. *Limoptera semiradiata* Frech, 1891, Steinkern-Fragment einer linken Klappe, Lateral-Ansicht, x 1,9, Länge 47mm; MnhnL EIA 517. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

7. *Cypricardinia crenistria* (Sandberger & Sandberger, 1854), Steinkern einer rechten Klappe, Lateral-Ansicht, x 1,4, Länge 23mm; MnhnL EIA 513. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

8. *Cypricardinia crenistria* (Sandberger & Sandberger, 1854), Steinkern einer rechten Klappe, Lateral-Ansicht, x 1,4, Länge 17mm; MnhnL EIA 598. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

9. *Cypricardinia crenistria* (Sandberger & Sandberger, 1854), Plastilin-Abdruck einer rechten Klappe (Schalen-Abdruck) zum Verdeutlichen der feinen, radial angelegten Einkerbungen zwischen den kommarginalen Rippen, Lateral-Ansicht, x 2, Länge 13mm; MnhnL EIA 595. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.


1a


1b


2


3


4a


4b


4c


5


6a


6b


6c


6d

Das Exemplar aus den Réideschbaach-Schichten bestätigt das Vorkommen von *H. cunea* bereits im tiefen Unter-Emsium. Sie fügt sich in die lange Liste mariner Invertebraten ein, die seit dem frühen Unter-Emsium entlang der Südküste des Old-Red-Kontinentes in westliche Richtung migriert sind. Bereits im Ober-Emsium, in der Schoharie-Formation Nord-Amerikas, ist sie ein fester Bestandteil der dortigen Fauna (Conrad, 1840).

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Tafel 2

1. ***Pterinopecten*** **(*Pterinopecten*)** ***follmanni*** (Frech, 1891), Steinkern einer linken Klappe; MnhnL EIA 518. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg,**1a.** Lateral-Ansicht des Steinkerns, x 1, Länge 58mm, **1b.** Silikon-Abdruck des Schalen-Abdrucks, x 1.

2. ***Goniomorpha*** **sp. aff.** ***G. rhenana*** (Beushausen, 1895), Steinkern einer rechten Klappe, Lateral-Ansicht, x 1,5, Länge 19mm; MnhnL EIA 514. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

3. ***Goniomorpha*** **sp.**, Steinkern-Fragment einer rechten Klappe, Lateral-Ansicht, x 1,5, Länge 21mm; MnhnL EIA 515. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

4. ***Goniomorpha stuertzi*** (Beushausen, 1895), Steinkern einer linken Klappe; MnhnL EIA 520. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg, **4a.** Ansicht von lateral, x 1, Höhe 36mm. **4b.** Ansicht von dorsal, x 1, **4c.** Ansicht von posterior, x 1.

5. ***Grammysia*** **sp. aff.** ***G. ovata*** Sandberger & Sandberger, 1854, Steinkern einer linken Klappe, Lateral-Ansicht, x 1, Länge 80mm; MnhnL EIA 397. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. ***Hoareicardia cuneus*** (Conrad, 1840), Steinkern mit abgebrochenem Rostrum; MnhnL EIA 514. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **6a.** Dexterolaterale Aufsicht, x 2, Länge 19,5mm, **6b.** Sinistrolaterale Aufsicht, x 2, **6c.** Aufsicht von posterior auf die Rostralfläche, x 2, **6d.** Aufsicht auf den Abdruck des klaffenden anterioren (ventralen) Gehäuserandes mit gut sichtbaren zahnartig gekerbten Marginal-Dentikel, x 2,5.

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Brachiopoda

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Schlüsselworte: Articulata, Inarticulata, *Atrypa (Atrypa) lorana*, Réideschbaach, Unterdevon, Luxemburg, Emsium.

Zusammenfassung

Durch die neue Grabung gestattet sich ein sehr viel umfangreicheres Bild auf die Brachiopodenfauna an der Lokalität Réideschbaach. Sie bildet in dieser tief unteremsischen Faunengemeinschaft nicht nur den quantitativ größten Anteil aller fossilen Nachweise, sondern weist auch das vielfältigste Artenspektrum auf. Viele Spezies werden von diesem Fundpunkt erstmals gemeldet, darunter *Protocortezorthis* ? sp. und *Rhenorensselaeria demerathia* Simpson, 1940. Gegenstand näherer Erörterungen oder Diskussion finden sich zu folgenden Arten: *Leptaenopyxis* cf. *kerfornei* Racheboeuf, 1976, *Gibbodouvillina* sp., *Arduspirifer*? sp., *Oligoptycherhynchus prodaleidensis* Mittmeyer, 2008, *Sartenaerirhynchus* cf. *frontecostatus* (Drevermann, 1902), *Anoplotheca venusta* (Schnur, 1853).

Neue, nahezu unverdrückte Funde von *Atrypa* (*Atrypa*) *lorana* Fuchs, 1915 veranlassten zu einer umfangreichen Analyse. Für diese Spezies wird neben der ausführlichen Beschreibung der Intern- wie Externmorphologie eine neue Diagnose gegeben.

Aufgrund des größten Teils der aufgefundenen Brachiopoden und ihrer bisher bekannten stratigraphischen Verbreitung, kann für die Réideschbaach-Schichten ein Alter im untersten Teil des Unter-Emsium angenommen werden. Die Zusammensetzung der Brachiopoden verweisen auf eine rheinisch-hercynische Mischfauna sensu Erben (1962).

Keywords: Articulata, Inarticulata, *Atrypa (Atrypa) lorana*, Réideschbaach, Lower Devonian, Luxembourg, Emsian.

Abstract

The new excavation allows a much more comprehensive picture of the brachiopod fauna at the Réideschbaach locality. In this deep Lower Emsian faunal community, it not only forms the quantitatively largest proportion of all fossil records, but also exhibits the most diverse spectrum of species. Many species are reported for the first time from this locality, including *Protocortezorthis*? sp. and *Rhenorensselaeria demerathia* Simpson, 1940. The following species are the subject of further discussion: *Leptaenopyxis* cf. *kerfornei* Racheboeuf, 1976, *Gibbodouvillina* sp., *Arduspirifer*? sp., *Oligoptycherhynchus prodaleidensis* Mittmeyer, 2008, *Sartenaerirhynchus* cf. *frontecostatus* (Drevermann, 1902), *Anoplotheca venusta* (Schnur, 1853).

New, almost uncompressed finds of *Atrypa* (*Atrypa*) *lorana* Fuchs, 1915 prompted a comprehensive analysis. In addition to a detailed description of the internal and external morphology, a new diagnosis is given for this species.

Based on the majority of the brachiopods found and their previously known stratigraphic distribution, an age in the lowest part of the Lower Emsian can be assumed for the Réideschbaach layers. The composition of the brachiopods points to a Rhenish-Hercynian mixed fauna sensu Erben (1962).

Mots-clés : Articulata, Inarticulata, *Atrypa (Atrypa) lorana*, Réideschbaach, Dévonien inférieur, Luxembourg, Emsien.

Résumé

La nouvelle fouille permet d'avoir une vision beaucoup plus large de la faune de brachiopodes du site de Réideschbaach.Dans cette communauté faunique de l'Ems profond, elle constitue non seulement la plus grande part quantitative de tous les fossiles identifiés, mais présente également le spectre d'espèces le plus diversifié. De nombreuses espèces sont signalées pour la première fois sur ce site, dont *Protocortezorthis* ? sp. et *Rhenorensselaeria demerathia* Simpson, 1940. Les espèces suivantes font l'objet d'un examen plus approfondi ou d'une discussion : *Leptaenopyxis* cf. *kerfornei* Racheboeuf, 1976, *Gibbodouvillina* sp, *Arduspirifer* ? sp., *Oligoptycherhynchus prodaleidensis* Mittmeyer, 2008, *Sartenaerirhynchus* cf. *frontecostatus* (Drevermann, 1902), *Anoplotheca venusta* (Schnur, 1853). De nouvelles découvertes presque intactes d'*Atrypa* (*Atrypa*) *lorana* Fuchs, 1915 ont incité à une analyse approfondie. Outre une description détaillée de la morphologie interne et externe, une nouvelle diagnose est donnée pour cette espèce.

Sur la base de la plupart des brachiopodes découverts et de leur répartition stratigraphique connue jusqu'à présent, on peut supposer que les couches de Réideschbaach sont âgées de la partie inférieure de l'Emsien inférieur. La composition des brachiopodes renvoie à une faune mixte rhéno-hercynienne sensu Erben (1962).

Danke

Für ihre engagierte Mitarbeit möchten wir unseren allerherzlichsten Dank aussprechen. Den Herren Dr. Ulrich Jansen und Martin Basse/ Forschungsinstitut und Naturmuseum Senckenberg Frankfurt a. M. für ihre fachliche Unterstützung, Andreas Abele-Rassuly/ Museum für Naturkunde Berlin für Fotos der Originale von Fuchs (1915), Manuel Nestle/Heidelberg für Sammlungsmaterial, Ralph Seibert/Ransbach-Baumbach, Dr. Otto Eichele/ Koblenz für die Herstellung einiger Silikonabgüsse.

1 Abkürzungen und Definitionen

DK = Dorsal-Klappe(n) = Arm-Klappe(n)

VK = Ventral-Klappe(n) = Stiel-Klappe(n)

Aabdr = Außen-Abdru(ü)ck(e) = Schalen-Abdru(ü) ck(e)

Stk = Steinkern(e)

MB - Museum für Naturkunde der Humboldt-Universität Berlin.

nhmM - Naturhistorisches Museum, Landessammlung für Naturkunde Rheinland-Pfalz in Mainz, Generaldirektion Kulturelles Erbe Rheinland-Pfalz, Direktion Landesarchäologie, Referat Erdgeschichte.

MnhnL - Sammlung des Musée national d´histoire naturelle Luxembourg.

Réideschbaach-Schichten – diese Bezeichnung wird hier als informeller Begriff für die Siltsteine mit Konkretionen und quarzitischen Sandsteine vom Réideschbaach benutzt. Sie entsprechen dem unteren Teil der Oberen Tonschiefer-Abfolge bei Lunkenheimer (Basse & Franke 2006: 9, Tab. 1).

REI 1 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'49.42''N, 6°00'27.05'' O.

REI 2 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'54.81''N, 6°00'19.40'' O.

REI 4 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'56.46''N, 6°00'03.38'' O.

REI 5 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'47.96''N, 6°00'36.55'' O.

REI 7 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°53'38.00''N, 5°59'24.78'' O.

2 Systematische Paläontologie

Klasse Rhynchonellata Williams, Carlson,
Brunton, Holmer & Popov, 1996

Ordnung ATRYPIDA Rzhonsnitskaia, 1960
Unterordnung ATRYPIDINA Moore, 1952
Überfamilie ATRYPOIDEA Gill, 1871
Familie ATRYPIDAE Gill, 1871
Unterfamilie ATRYPINAE Gill, 1871
Genus *Atrypa* Dalman, 1828
Subgenus *Atrypa* (*Atrypa*)

Systematik nach Copper, 2002: 1388.

***Atrypa* (*Atrypa*) *lorana* Fuchs, 1915**
Taf. 1: 1-4, Taf. 2: 10-11.

● 1899 *Atrypa reticularis* Gmelin: Fuchs, Unterdevon der Loreleigegend, S. 13, 15, 22.

⁎ v 1915 *Atrypa lorana* n. sp.: Fuchs, Loreleigegend, S. 21-22, Taf. 5, Fig. 4-8.

non 1930 *Atrypa lorana* Fuchs: Asselberghs, Faunes Marines du Gedinnien, S. 35-36, Taf. 4, Fig. 4-6 [= *Atrypa gedinniana* Fuchs, 1934].

1935 *Atrypa lorana* Fuchs: Mauz, Vergleichende Untersuchungen, S. 23, 80, Taf. 3, Fig. 23, 24a, b [Vorkommen am Winkelbach bei Oberstadtfeld].

? 1938 *Atrypa lorana* Fuchs: Maillieux, Couvinien, S. 6, 12 [aus "grauwacke de Bure"].

● 1939 *Atrypa lorana* A. Fuchs: Lippert, Daleider Mulden-Gruppe, S. 17, 19.

? 1940 *Atrypa* sp. aus der *reticularis*-Gruppe (. . . vermutlich *Atrypa lorana* A. Fuchs): Dahmer, neu erschlossener Versteinerungs-Fundpunkt im östlichen Taunus, S. 139.

1941 *Atrypa lorana* Fuchs: Maillieux, Brachiopodes de L'Emsien de l'Ardenne, S. 11, 41-42.

? 1942 *Atrypa lorana* Fuchs: Renaud, Synclinorium Médian Brest-Laval, S. 166, 167, 331, 362 [nennt als Vorkommen "Grauwackes" von Mayenne aus "Siegenien"].

● 1953 *Atrypa* (*Atrypa*) *lorana* Fuchs, 1915: Rösler, Bornicher Schichten, Taf. 8, Fig. 26.

● 1954 *Atrypa lorana* Fuchs: Dahmer, Zwei neue Fossilfundpunkte in den Singhofener Schichten des östlichen Taunus, S. 39 [Fossilvorkommen bei Cratzenbach].

1965 *Atrypa lorana*: Copper, Devonian Atrypids, S. 28, 29.

● 1971 *Atrypa* (*Atrypa*) *lorana* Fuchs, 1915: Jahnke, Erbslochgrauwacke, S. 46-47, Taf. 11, Fig. 20, Taf. 2, Fig. 12, 13 [Beschreibung].

● 1973 *Atrypa lorana* Fuchs: Mittmeyer, Wisper-Gebiet, S. 24, 27, 35, Taf. 14, Fig. 14.

1989 *Atrypa lorana* Fuchs: Fuchs, Neuerburg, S. 14.

v 2006 *Atrypa lorana* Fuchs: Basse & Franke, Marine Faunen, S. 11, 12, Taf. 1, Fig. 6.

● 2006 *Atrypa lorana* Fuchs: Franke, Klerf-Schichten, S. 50, 68.

non 2019 *Atrypa lorana* Fuchs: Mottequin, Catalogue, S. 65 [*Atrypa gedinniana* Fuchs 1934 aus Gedinne = Synonym von *Atrypa lorana*].

Lectotypus: Nach Mauz (1935: 80) der Abdruck einer Stielklappe bei Fuchs (1915, Taf. 5, Fig. 5), aufbewahrt im Museum für Naturkunde Berlin, Inventarnummer MB.B 329.2a-b. Fund Fuchs 1913.

Paralectotypen: Fuchs (1915) Taf. 5 Fig. 4, Fund Fuchs 1913 (MB.B 329.1), Fig. 6, Fund Fuchs1913 (MB.B 329.3), Fig. 7, Fund Fuchs 1903 (MB.B 329.4), Fig. 8, Fund Fuchs 1913 (MB.B 329.8).

Locus typicus: Galgenkopf an der Loreley. Fundpunkt von Fuchs ungefähr bei N50° 08' 41.0" E7° 43' 54.8", Topographische Karte 1:25000, 5812 St. Goarshausen.

Stratum typicum: Bornich-Formation, Ulmen-Gruppe, Unter-Emsium, Unterdevon.

Geographische und stratigraphische Verbreitung: Frankreich, unsicher im Armorikanischen Massiv; Belgien, Ardennen, Grauwacke de Pesche: Unter-Emsium Em1a (Maillieux 1941: 42); Luxemburg, Oesling, Réideschbaach-Schichten: unteres Unter-Emsium (siehe hier); Deutschland, Rheinisches Schiefergebirge, Mittelrheinregion, Eifel, Taunus; Unter-Emsium, Ulmen-Gruppe, Bornich-Formation: Mittelrhein, Loreleyregion bei St. Goarshausen: Galgenkopf, Eredill bei Bornich, sowie "Wegeinschnitt an der Lorcher Straße südlich Ransel im Sauertaler Horizont; Ranselbacher Kopf" (Fuchs 1915: 21-22). Taunus, Unter-Emsium, mittlere bis obere Ulmen-Gruppe, Kaub-Formation: Wisper-Gebiet (Mittmeyer 1973: 24, 27, 35). Taunus, Singhofen-Gruppe: Cratzenbach, Steinbruch 396 m E Eichelbacher Hof (Dahmer 1954: 39). Untere Vallendar-Gruppe, Rittersturz-Formation: Vallendar bei Koblenz, Feisternachttal, Hang nordöstlich der Pilgerkirche (siehe Tabelle xx). Obere Vallendar-Gruppe, Klerf-Formation: Eifel, Raum Daleiden, "Straße nach Mauel" (Lippert 1939: 17, Beleg: SMF XVII 306f; Franke 2006: 68). Kellerwald, Erbslochgrauwacke: Unter-Emsium (Jahnke 1971: 46-47).

Untersuchtes Material: Lectotypus und Paralectotypen aus dem Museum für Naturkunde Berlin; doppelklappiges Exemplar vom Réideschbaach, MnhnL EIA 577 (REI 1); Abdrücke von zwei VK auf einer Platte, Fundort Galgenkopf Loreley, Fund Wenndorf 27.07.1978, PWL 2020/5596-LS (Naturhistorisches Museum Mainz, Landessammlung für Naturkunde Rheinland-Pfalz); Abdruck einer VK, Speckgraben im Feisternachttal bei Vallendar, Fund Wenndorf 10.09.1975, PWL 2021/6293-LS; vom gleichen Fundort doppelklappiger Stk, PWL2021/6282-LS; Abdruck einer VK, Fundort Vallendar, Hang NE Pilgerkirche, Fund Manuel Nestle/Heidelberg, PWL 2021/6720-LS, PWL 2021/6746-LS, Fund Seibert/Ransbach-Baumbach.

Weiteres Material von Réideschbaach bei Heiderscheid: 2 doppelklappiger Stk mit 2 Aabdr, 6 Stk DK mit Aabdr, 14 Stk DK, 2 Stk VK mit Aabdr, 5 Stk VK.

Geschichte:

- Fuchs (1915) begründet die Art mit Funden aus der Loreleyregion am Mittelrhein und nennt in der Beschreibung der Rippenstruktur ("Skulptur") Unterschiede zu *Atrypa reticularis*.
- Asselberghs (1930) stellt Funde von Ovifat aus dem Gedinnium der Ardennen zu *A. lorana*. Fuchs (1934) stellt diese Funde zu *Atrypa gedinniana*.
- Mauz (1935) legt den Lectotypus fest.
- Lippert (1939) macht erstmals Funde aus dem hohen Unter-Emsium (Klerf-Formation) der West-Eifel bekannt.
- Maillieux (1941) nennt ein Vorkommen von *A. lorana* aus Assise de Vireux, "Grauwacke de Pesche", Em1a (Unter-Emsium).
- Renaud (1942) beschreibt Funde aus der Bretagne. Als Charakteristikum kennzeichnet sie die mehrfache und unregelmäßige Dichotomisierung der Rippen besonders in der Frontalregion.
- Jahnke (1971) beschreibt Funde aus der Erbslochgrauwacke des Kellerwalds und ergänzt die Beschreibung von Fuchs.
- 2006: Erstnachweis in Luxemburg durch Franke *in* Basse & Franke.

Diagnose für adulte Exemplare: Länge meist zwischen 35 bis ca. 40 mm. 30 bis ungefähr 46 kräftige Rippen mit schuppigen, dachziegelähnlichen Anwachslamellen. Abstand zwischen den Anwachslamellen beträgt ungefähr die ein bis dreifache Faltenbreite, am Vorderrand von adulten Exemplaren bedeutend enger. Rippenvermehrung durch Bifurkation und Interkalation besonders im vorderen Drittel der Klappen. Adduktorabdrücke der VK klein, bohnenförmig, flach, im Zentrum einer Depression, durch dünnes Myophragma getrennt, umgeben von großen Diduktorabdrücken.

Diagnosis for adult specimens: Length mostly between 35 to ca. 40 mm. 30 to approximately 46 strong costae with squamous, roof-tile-like growth lamellae. Distance between the growth lamellae is about one to three times the width of the folds, significantly narrower on the anterior margin of adult specimens. Increase of costae by bifurcation and intercalation especially in the anterior third of the valves. Adductor scars of the ventral valve small, bean-shaped, flat, in the centre of a depression, separated by a thin myophragma, surrounded by large diductor impressions.

Beschreibung:

Allgemeine Form der geschlossenen Klappen

VK apikalkonvex, mit leicht konvexem Umbo. DK kräftig konvex, in Aufsicht subzirkular bis fast breitoval. Sulcus der VK in der Nähe des Frontalrandes bei Adultexemplaren schwach entwickelt, bei juvenilen Klappen lediglich angedeutet. Maximale Dicke in Lateralansicht in der Mitte der DK. Maximale Klappenweite bei ungefähr 70-80 % der Klappenlänge ausgehend vom Frontalrand. Maximale Klappengröße adult zwischen 35 bis ca. 40 mm. Dorsale Falte bei adulten Exemplaren frontal oft angedeutet bis fehlend. Schnabel angedrückt, Foramen klein, transapikal (Copper 2002: 1386, Fig. 937.3). Area fehlt. Kommissur frontal leicht nach dorsal, lateral geringfügig nach ventral gebogen, in manchen Fällen fast gestreckt. Anzahl der Rippen ungefähr zwischen 30 bis 46. Rippen im mittleren Teil adulter VK in Aufsicht gerade gestreckt, posterolateral besonders in Kommissurnähe leicht gebogen. Rippen adulter DK im mittleren Bereich gerade gestreckt, Lateralrippen deutlich gebogen. Bei juvenilen Exemplaren Rippenbiegung nur in Andeutungen sichtbar. Kräftige, auf dem Top gut gerundete Rippen mit schuppigen, dachziegelähnlichen, unregelmäßigen Anwachslamellen, "deren frei überragende Enden etwa so lang sind wie die Breite der Falten. Der Abstand zwischen den einzelnen Anwachslamellen ist unterschiedlich, i.A. recht groß (etwa ein- bis dreifache Faltenbreite), am Vorderrand von Adultexemplaren wesentlich enger" (Jahnke 1971: 77). Rippenvermehrung durch Bifurkation und gelegentliche Interkalation besonders im vorderen Drittel der Klappen. Zwischen den freien Enden der Anwachslamellen befinden sich bei scharfer Erhaltung 5-10 schwache Anwachsrüschen ("frill", Copper 2002: 1384, Fig. 935).

Internmorphologie

DK: Beide Sockelplatten schließen die Kardinalgrube ("cardinal pit", Copper 2002: 1380, Fig. 932) zwischen sich ein, die als kräftige Leiste erscheint, gelegentlich eine zentrale Rinne einschließend. Kammartiger Schlossfortsatz (cardinal process) aus feinen, unregelmäßig stehenden Leisten am apikalnahen Teil der Kardinalgrube. Vorderer Teil der Kardinalgrube als Anhaftstelle der Diduktoren oft mit variablen Leisten auf dem mittleren Zahngrubenrand mit feinen Knoten versehen. Zähne massiv mit zusätzlichen Loben (Copper 2002: 1381, Fig. 933). Septum kurz, apikal breiter. Anhaftstellen der dorsalen Adduktoren oval, oft undeutlich, auf jeder Seite des Septums mit einigen groben, variablen und unscharfen Streifen gekennzeichnet. Muskelfeldbegrenzungsleiste fehlt oft oder ist undeutlich. Cruralbasen wegen ungünstiger Erhaltung des Materials nicht deutlich erkennbar. VK: Adduktorabdrücke klein, bohnenförmig, flach, im Zentrum einer Depression in der VK, durch dünnes Myophragma getrennt. Diduktorabdrücke groß, breit, deutlich abgegrenzt, fächerförmig, kräftig in die VK vertieft, auf dem StK gewölbt. Muskelfeldbegrenzungsleiste fehlt. Im Zentrum des ventralen Muskelfeldes ein dünnes ventrales Septum angedeutet. Raum außerhalb der ventralen Muskelabdrücke dicht mit Vertiefungen (Ovarien?) ausgefüllt, die in

Tab. 1: Rippenzahlen bei *Atrypa* (*Atrypa*) *lorana* und *Atrypa* (*Atrypa*) "*reticularis*".

Atrypa (***Atrypa***) ***lorana*** Fuchs 1915	Rippenzahl mm Apikaldistanz	***Atrypa*** (***Atrypa***) "***reticularis***" der VK in 23 (Linnaeus 1758)	Rippenzahl der VK in 23 mm Apikaldistanz
Galgenkopf Loreley – a, Fund Wenndorf, PWL 2020/5596-LS	ca. 30	Lahnstein, Allerheiligenberg, Fund Wenndorf, PWL 2020/5897-LS	74
Galgenkopf Loreley – b, Fund Wenndorf, PWL 2020/5596-LS	32	Steinsberg, Fund Wenndorf, PWL 2021/6760-LS	54
Réideschbaach, Fund Franke	41	Lahnstein, Karstel, Fund Wenndorf, PWL 2021/6761-LS	68
Vallendar, Feisternachttal, Fund Wenndorf PWL 2021/6294-LS	36	Braubach, Alte Gahnert, Fund Wenndorf, PWL 2021/6762-LS	82
Vallendar, Feisternachttal, Fund Wenndorf PWL 2021/6293-LS	33	Heiligenroth, Fund Seibert, PWL 2021/6757-LS	66
Galgenkopf, Loreley, Fuchs (1915, Fig. 5)	Ca. 46	Heiligenroth, Fund Seibert, PWL 2021/6758-LS	70
Galgenkopf, Loreley, Fuchs (1915, Fig.8)	Ca. 46		
Vallendar, Pilgerkirche, Fund Seibert, PWL 2021/6747-LS	40		
Vallendar, Pilgerkirche, Fund Seibert, PWL 2021/6746-LS	40		

unregelmäßig gewellten Reihen vom Frontalrand aus nach hinten verlaufend das Muskelfeld umfassen.

3 Diskussion

Über *Atrypa* im Ober-Emsium des Rheinischen Schiefergebirges ist bisher nur sehr wenig bekannt. Die Nennung in Fossillisten bisheriger Autoren geben lediglich die pauschale Bezeichnung *Atrypa* (*Atrypa*) "*reticularis*" an. Der Typus dieser Art stammt aus dem unteren Ludlow von Gotland (Silur). Es darf sehr wahrscheinlich angenommen werden, dass sich daraus im Unterdevon weitere Arten entwickelt haben. Eine Untersuchung darüber steht bisher aus. Trotzdem lässt sich *Atrypa* (*Atrypa*) *lorana* von den Funden von *A.* (*A.*) "*reticularis*" aus dem Ober-Emsium deutlich unterscheiden. Die von Renaud (1942) beobachtete Dichotomisierung der Rippen scheint ein bedeutendes Merkmal zu sein, da diese bei *A.* (*A.*) "*reticularis*" weniger deutlich ausgeprägt ist. Als relevant erweist sich die Rippenzahl. Das vorliegende geringe Material von *A.* (*A.*) *lorana* zeigt auf der VK eine Rippenzahl von ca. 30-46. Eine Beobachtung, die durch eine größere Anzahl von Messungen gesichert werden müsste. Für *A.* (*A.*) "*reticularis*" beträgt die Rippenzahl 54-82. Von großer Bedeutung ist der von Jahnke (1971) betonte meist große Abstand zwischen den einzelnen Anwachslamellen, der bei *A.* (*A.*) "*reticularis*" aus dem Ober-Emsium stets dichter ist. Dazu kommt noch, dass *A.* (*A.*) "*reticularis*" keine aufgeworfenen Schuppen auf den Anwachslamellen hat wie *A.* (*A.*) *lorana*. *A.* (*A.*) "*reticularis*" von den Fundorten Lahnstein, Allerheiligenberg und Heiligenroth unterscheiden sich durch weniger bis fast nicht konkave VK mit deutlich breiteren Adduktorabdrücken.

Fundorte und Aufbewahrung der Vergleichsexemplare von *Atrypa* (*Atrypa*) *lorana* Fuchs, 1915 und ***Atrypa* (*Atrypa*) "*reticularis*"** (Linnaeus, 1758):

St. Goarshausen, Galgenkopf an der Loreley, Locus typicus, Blatt St. Goarshausen: N50° 8' 41.00" E7° 43' 54.88". Unter-Emsium, Bornich-Formation, Fund *A.* (*A.*) *lorana*, PWL 2020/5596-LS, nhmM.

Vallendar, Hang 290 m E Pilgerkirche (Aumühle), BD10, Blatt Bendorf: N50° 24' 11.80" E7° 38' 12.30". Unter-Emsium, Vallendar-Gruppe, vermutlich oberer Teil der Rittersturz-Formation. Fund *A.* (*A.*) *lorana*, PWL 2021/6746-LS, PWL 2021/6747-LS, nhmM.

Vallendar, Wegbiegung am Speckgraben, BD5, mittlerer Hangweg im Feisternachttal E Vallendar, Blatt Bendorf: N50° 24' 45.90" E7° 39' 03.70". Unter-Emsium, Vallendar-Gruppe, Rittersturz-Formation. Fund *A.* (*A.*) *lorana*. PWL 2021/6293-LS, PWL 2021/6294-LS, nhmM.

Lahnstein, Allerheiligenberg, Blatt Koblenz: N50° 18' 39.80" E7° 37' 08.60", Ober-Emsium, Laubach-Gruppe. Fund *A.* (*A.*) "*reticularis*", PWL 2020/5897-LS, nhmM.

Heiligenroth bei Montabaur, 100 m S Autobahnraststätte, Blatt Meudt, MD1: N50° 27' 12.3" E7° 52' 15.8". Ober-Emsium, obere Kondel-Gruppe, Kieselgallenschiefer-Formation. Fund *A.* (*A.*) "*reticularis*", PWL 2021/6757-LS, nhmM.

Steinsberg, Steinbruch zwischen Rupbach- und Wasenbachtal, nördlicher Steinbruchs-Rand 225 m südwestlich der Heckelmann-Mühle, Blatt Schaumburg: N50° 18' 52.5" E7° 56' 29.7". Hohes Ober-Emsium, Rupbach-Schiefer. Fund *A.* (*A.*) "*reticularis*", PWL 2021/6761-LS nhmM.

Braubach, "Alte Gahnert", Felsböschung an der SE-Ecke des Sportplatzes, BOP118, Blatt Boppard: N50° 16' 30.00" E7° 39' 47.60". Ober-Emsium, obere Kondel-Gruppe, Kieselgallenschiefer-Formation. Fund *A.* (*A.*) "*reticularis*", PWL 2021/6762-LS nhmM.

4 Bemerkungen zu weiteren Arten

4.1 Inartikulate Brachiopoden

Bemerkungen: Die wenigen uns vorliegenden Nachweise gestatten immerhin zwei taxonomische Zuschreibungen. Für unter-emsische Formen des ardenno-rheinischen Raumes sind, bis auf *Merglia schwerdi* (Drevermann, 1902), alle bislang bekannten Taxa anderer Craniiden unvollständig und vielleicht aufgrund des unzureichenden Materials noch relativ unbearbeitet. So listet Mauz (1935: 78) in seiner vergleichenden

Monographie der "Stadtfeld"-Schichten (oberes Unter-Emsium) neben *M. schwerdi* lediglich kleinmuskelige Formen von *Petrocrania proavia* (Goldfuss, 1840) auf, die hier wahrscheinlich als Sammelbegriff gesehen wurden. Siehe dazu auch Franke (2012: 133-147).

Merglia Franke, 2012

Merglia schwerdi (Drevermann, 1902); Material: 1 kleine Stk Dk, (REI 1), Breite 11mm; Taf. 2 Fig. 3.

Beschreibung und Diskussion: siehe Dahmer 1930: 93-94, Taf. 6 Fig. 3; Franke 2012: 137-139, Abb. 1a-c, Taf. 1 Fig. 2-7, Taf. 2 Fig. 1-4. EIA 678, juveniles Exemplar mit Andeutung der feingliedrigen Schalen-Skulptur.

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich mittleres Ober-Emsium.

Petrocrania Raymond, 1911

Petrocrania krautscheidensis Franke, 2012; Material: 2 Stk-Fragment DK; MnhnL EIA 319, (REI 5) Breite 26mm, MnhnL EIA 414, (REI 2) Breite 28mm; Taf. 2: 4, 5.

Beschreibung und Diskussion: Die Stk-Fragmente lassen sich durch den gut sichtbaren marginalen Randsaum sicher der Gattung *Petrocrania* zuordnen. Außenabdrücke sind nicht vorhanden. Bei dem Stück EIA 319 ist der posteriore Rand nicht erhalten. Der quer-verlängerte, abgestutzt ovoide Klappenumriss, die Lage und Größe der anterioren (groß) und posterioren Muskel-Ansatzstellen entsprechen dem Typus von *Petrocrania krautscheidensis* Franke, 2012, (siehe dort: 142-143, Abb. 3a-c, Taf. 2 Fig. 6). Im Vergleich mit den oberemsischen Formen (siehe Franke 2012: 139-146) stellt sich generell die Frage nach der intraspezifischen Variabilität innerhalb der Spezies dieser Gattung. Siehe dazu auch Wolf (1930: 49-50).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich mittleres Ober-Emsium.

Craniidae gen. et sp. indet; Material: 1 große Stk DK mit Aabdr., MnhnL EIA 679, (REI1), Breite 19mm, 1 kleine Stk Dk. MnhnL EIA 680, (REI2), Breite 11,4mm.

Beschreibung und Diskussion: EIA 679; Taf. 2: 6. Ein größerer Stk mit Schalen-Abdruck (Länge 20mm, Breite 18mm; Höhe 5mm), besitzt einen ovalen, hoch-verlängerten Klappenumriss und eine gleichförmige Wölbung. Die unterschiedlich großen Muskel-Ansatzstellen der anterioren Adduktoren liegen in einer eingesenkten Mulde hinter dem höchsten Punkt, ziemlich in der Mitte der mützenartig schwach erhobenen DK. Die rechte Muskel-Ansatzstelle ist fast doppelt so groß wie die linke. Die Muskel-Ansatzstellen der posterioren Adduktoren sind etwas größer als die rechte Muskel-Ansatzstellen des anterioren Adduktors.

Im Gegenabdruck sind für die taxonomische Bestimmung keine verwertbaren Strukturen erkennbar. Die gesamte ehemals kalzitische Schale ist mit Epöken verschiedener Bryozoen besetzt.

EIA 680, kleine, hohe, unvollständige und verdrückte DK ohne Gegenabdruck.

4.2 Artikulate Brachiopoden

***Leptaena* sp.**; Material: 5 Stk DK mit Aabdr, 9 Stk DK, 1 Stk VK mit Aabdr, 4 Stk VK, 1 Stk VK-Aabdr; Taf. 2: 7-10.

Beschreibung und Diskussion: Cox & Rong (2000: 241-252); Die Arten der Gattungen *Leptaena* Dalman, 1828 und *Leptagonia* M´Coy, 1844 sind für das Emsium im ardenno-rheinischen Raum faktisch so gut wie unbearbeitet, so dass eine Determinierung zum jetzigen Zeitpunkt nicht angebracht erscheint.

Leptaenopyxis* cf. *kerfornei Racheboeuf, 1976; Material: 2 Stk DK mit Aabdr; Taf. 2: 11a-d, 12.

Beschreibung und Diskussion: Cox & Rong (2000: 246), Racheboeuf (1976: 719-739).

Diese Form gehört zu einer sehr interessanten Gattung, deren Arten in Sedimenten mit rein hercynischer Fazies, wie auch rheinisch-hercynischer Mischfazies gerechnet werden. Die Typus-Art *Leptaenopyxis bouei* (Barrande, 1848) stammt aus dem Pragium von Koněprusy (Tschechische Republik). Im Zusammenhang mit den unter-devonischen Ablagerungen des Rhei´schen Ozeans finden sich in der älteren Literatur einige Beschreibungen und Hinweise zu *Leptaenopyxis* "*bouei*". Dazu gehören unter anderem die Erbsloch-Grauwacke im Kellerwald, Deutschland (Assmann 1910: 164, Taf. 10 Fig. 1, 2), das hercynische Unter-Devon bei Marburg, Deutschland (Herrmann

1912: 331), die Siegener Rauhflaser-Schichten von Neuwied, Deutschland (Dahmer 1931: 88), die Siegener Quartzophylladen von Longlier, Belgien (Asselberghs 1913: Taf. 3 Fig. 6, 7; Maillieux 1936: 71), verschiedene Fundpunkte im Armorikanischen Massiv, Frankreich (Racheboeuf 1976) und der unter-emsischen Mariposas-Fm. der keltiberischen Ketten, Spanien (Carls 1972: 126, 143). Allergrößte morphologische Übereinstimmung mit unserem Material findet sich mit der von Asselberghs (1913: Taf. 3 Fig. 6) abgebildeten DK. Der nicht weit vom Réideschbaach entfernt liegende Fundpunkt Louftémont in Belgien wird bislang zu den Quartzophylladen von Longlier mit Ober-Siegenium-Alter gerechnet.

Racheboeuf (1976) untersuchte das Material zu "*bouei*" des Armorikanischen Massivs und konnte vier verschiedene Formen differenzieren, die nicht mit der Typus-Art identisch waren. Es ist zu erwarten, dass die meisten aus den anderen Fund-Punkten aufgeführten Exemplare ebenso wenig zu *bouei* gehören.

Unser Material, obwohl nicht deformiert, ist noch zu gering und Vergleichsmöglichkeiten stehen uns zurzeit nicht zur Verfügung. Neue Erkenntnisse ließen sich durch eine geplante Neubearbeitung und Material-Aufsammlung im Raum Longlier erhoffen (pers. Mitteilung A. Hellemond, Brüssel), der nicht sehr weit vom Fund-Punkt Réideschbaach entfernt ist.

Gigastropheodonta* sp. aff. *gigas (McCoy, 1852); Material: 2 Stk VK mit Aabdr, 1 Stk VK; Taf. 3: 1a, b.

Diskussion: Jansen (2014: 122).

Stratigraphische Verbreitung für *G. gigas*: mittleres Siegenium bis einschließlich unteres Unter-Emsium.

Leptostrophiella explanata (Sowerby, 1842); Material: 2 Stk DK mit Aabdr, 1 Stk DK, 3 Stk VK, 3 Stk VK mit Aabdr; Taf. 3: 2-4, 6.

Beschreibung und Diskussion: Jahnke (1971: 55-59), Jansen (2014: 129, Fig. 6 A-B).

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich mittleres Ober-Emsium.

Pseudoleptostrophia dahmeri (Rösler, 1954): Material: 1 Stk DK, 1 Stk VK, 1 Stk VK mit Aabdr; Taf. 3: 5, 6.

Beschreibung und Diskussion: Jahnke (1971: 59-60), Gad (1997: 191-200). Durch den meist querverlängerten Klappenumriss, das semielliptische Muskelfeld und den subelliptischen Grubenfortsatz lässt sich die Art von *Leptostrophiella explanata* trennen, was mitunter nicht immer einfach ist, da beide Arten gleichzeitig vorkommen können.

Verglichen mit Exemplaren aus dem oberen Unter-Emsium ist bei unserem Stück die Muskelbegrenzungslinie nur sehr schwach ausgeprägt, was auf eine frühe Form dieser Spezies hindeutet. Siehe auch Jansen (2014: 129, Fig. 6 E-F).

Stratigraphische Verbreitung: unteres bis einschließlich oberes Unter-Emsium.

***Gibbodouvillina* sp.**; Material: 6 Stk VK mit Aabdr, 6 Stk VK, 1 DK; Taf. 4: 1, 2, 3a, b, 5, 6.

Beschreibung und Diskussion: Ganz bewusst werden die Stücke vom Réideschbaach hier als *Gibbodouvillina* sp. bezeichnet, da sie sich doch etwas von *Gibbodouvillina taeniolata* (Sandberger & Sandberger, 1856) unterscheiden. Besonders die Form und Begrenzung des ventralen Muskelfeldes sind auffällig (Siehe dazu den bei Jansen (2014: Fig. 5 E) abgebildeten Lectotypus.). DK sind äußerst selten überliefert. Dieser Umstand lässt sich nur sehr hypothetisch der unterschiedlichen postmortalen Einkippung exartikulierten Klappen zuschreiben. Diese Beobachtung deckt sich auch mit Bivalven mit einer napfförmigen und einer flachen Schale, wie Vertreter der Gattung *Cornellites* Williams, 1908. Eine Erklärung könnte der bessere Transport flacher Schalenteile zum Spülsaum sein und damit die größere Wahrscheinlichkeit der mechanischen Abrasion.

Stratigraphische Verbreitung: unteres Unter-Emsium.

Fascistropheodonta sedgwicki (d´Archiac & de Verneuil, 1842); Material: 2 Stk DK mit Aabdr, 1 Stk DK; Taf. 4: 7.

Beschreibung und Diskussion: Harper & Boucot (1978: 24-25, Taf. 45 Fig. 2-6), Jansen (2014: Fig. 6 Fig. M).

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich mittleres Unter-Emsium.

Platyorthis circularis circularis (Sowerby, 1842); Material: 1 Stk VK mit Aabdr, 1 VK; Taf. 4: 8a, b, 10a, b.

Beschreibung und Diskussion: Jansen (2001: 94-95).

Stratigraphische Verbreitung: Unter-Emsium.

Platyorthis nocheri (Fuchs, 1915); Material: 1 Stk DK, 4 Stk VK, 1 Stk VK mit Aabdr; Taf. 4: 9, 11a, b.

Beschreibung und Diskussion: Fuchs (1915: 15-16); Jansen (2001: 98).

Stratigraphische Verbreitung: Unter-Emsium.

Rhenoschizophoria provulvaria (Maurer, 1886); Material: 3 Stk DK, 1 Stk VK mit Aabdr; Taf. 4: 12-14.

Beschreibung und Diskussion: Jansen (2001: 113-115).

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich oberes Unter-Emsium (Stadtfeld-Schichten).

Plebejochonetes semiradiatus (Sowerby, 1842); Material: teilweise Schilllagen, sehr häufig; Taf. 5: 1.

Beschreibung und Diskussion: Racheboeuf & Fuchs (1978: 179-181, Taf. 2 Fig. 1a-k).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich mittleres Ober-Emsium.

Plebejochonetes unkelensis (Dahmer, 1936); Material: 1 VK, 1 VK mit Aabdr., 1 DK mit Aabdr; Taf. 5: 2.

Beschreibung und Diskussion: Racheboeuf & Fuchs (1978: 175-179, Taf. 1 Fig. 3a-e, Taf. 2 Fig. a-f).

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich tiefes Unter-Emsium.

Loreleiella extensa (Kayser, 1889); Material: 1 VK, 1 VK mit Aabdr; Taf. 5: 3a, b, 4.

Beschreibung und Diskussion: Racheboeuf & Fuchs (1978: 182-183, Taf. 3 Fig. 2a-j).

Stratigraphische Verbreitung: oberes Siegenium bis einschließlich oberes Unter-Emsium.

Loreleiella dilatata (Roemer, 1844); Material: 2 Stk DK; Taf. 5: 5a, b.

Beschreibung und Diskussion: Racheboeuf & Fuchs (1978: 184-185, Taf. 4 Fig. 2a-q).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich obere Ober-Emsium.

***Protocortezorthis* ? sp.**; Material: 1 Stk VK mit Aabdr; Taf. 4: 15.

Bemerkungen zu der vermutlich nahestehenden Art *Protocortezorthis trigeri* (de Verneuil, 1850): Jahnke (1971: 75-76).

Tropidoleptus rhenanus Frech, 1897; Material: 1 DK mit Aabdr, 1 DK- Aabdr, 1 VK mit Aabdr; Taf. 5: 6a, b, 7a, b.

Beschreibung und Diskussion: Jansen (2001: 149).

Stratigraphische Verbreitung: Unter-Emsium.

Oligoptycherhynchus prodaleidensis Mittmeyer, 2008; Material: EIA 349 – VK, (REI 7) L 19,8 mm, W 15,3 mm; Rippen ventral 8, median 3, mit verstärkter Mittelrippe; EIA 364 – doppelklappiger Stk (REI 5), L 15,6 mm, W15,0 mm (Taf. 4 Fig. 9a, b); EIA 557 - VK mit Außenabdruck (REI 2), L 10,2 mm, W 13,4 mm (Taf. 4 Fig. 8); EIA 358 – VK (REI 2), L 11,0 mm, W 14,5 mm; EIA 559 – DK (REI 1), L 11,5 mm, W 10,4 mm (Taf. 4 Fig. 10); weiteres Material (REI 2): 2 VK, 1 DK.

Holotypus: Innenabdruck einer VK, Mittmeyer (2008: 200, Taf. 1, Fig. 17).

Locus typicus: Schutz / Eifel.

Stratum typicum: Unter-Emsium, Ulmen-Gruppe, Reudelsterz-Formation.

Stratigraphische Verbreitung: Nach Mittmeyer (2008: 203) "Mittelsiegen bis obere Ober-Ulmen".

Beschreibung und Diskussion: Mittmeyer (2008: 186-190) nennt die Art in Fossil-Listen vom unteren Mittelsiegen bis zur oberen Ulmen-Gruppe. Da außer dem Holotypus und einem Paratypus (DK) von Schutz keine weiteren Exemplare von Mittmeyer abgebildet und mit anderen *Oligoptycherhynchus*-Funden aus dem genannten stratigraphischen Bereich verglichen werden, bleiben die Aussagen zur Lebenszeit unsicher.

Mittmeyer (2008: 200, 203, Taf. 1, Fig. 17-18) begründet die neue Art *Oligoptycherhynchus prodaleidensis* mit der Abbildung des Innenabdrucks einer Ventral- und einer DK und der Merkmalskombination "geringe Größe, (. . .) geringfügig gegen die Flanken abgesetzte und dementsprechend schwach eingedellte, kaum nach vorn-unten ausladende Sinus-Partie und dünne, rel. lange Zahnstützen". Damit soll die Art der Vorläufer von *Oligoptycherhynchus daleidensis gracilior* (Fuchs) sein. Sartenaer (2010: 55) kritisiert die Bezugnahme als unbefriedigend. Der einzige Bezug zu *daleidensis* sei die Anzahl der Mittelrippen (dorsal 4, ventral 3) und die Zuweisung zur Gattung *Oligoptycherhynchus* sei irrtümlich.

Oligoptycherhynchus* aff. *daleidensis (Roemer, 1844); Material: EIA 425 – DK (REI 2), L 15,0 mm; W 16,1 mm (Taf. 6 Fig. 4); EIA 376 - (REI 4), L 10,0 mm, W 15,5 mm; EIA 560 – VK (REI 1), verdrückt? L 9,5 mm, W 10,1 mm (Taf. 6 Fig. 2); EIA 562 – VK, L 10,6 mm, W 9,5 mm (Taf. 5 Fig. 12); EIA 561 – VK (REI 2), L 8,9 mm, W 10,5 mm (Taf. 6 Fig. 3); REI 1, EIA 563 – DK mit Aabdr (REI 1), L 9,6 mm. W 12,6 mm; weiteres Material: 2 VK-Fragment, 2 DK, 1 DK mit Aabdr.; Taf. 6: 1, 5.

Beschreibung und Diskussion von *Oligoptycherhynchus daleidensis* (Roemer, 1844) aus den Wiltz-Schichten im Ober-Emsium: Sartenaer (2010). Unter der Bezeichnung *Oligoptycherhynchus* aff. *daleidensis* werden hier bruchstückhaft und nicht klar bestimmbare Reste sowie DK zusammengefasst, die sich durch ihre Ähnlichkeiten nicht klar identifizieren lassen.

Straelenia dunensis (Drevermann, 1902); Material: 2 Stk VK; Taf. 6: 6, 7.

Beschreibung und Diskussion: Drevermann (1902: 108-109); siehe auch Wenndorf (2001: Taf. 5 Fig. 4, 5).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich unteres Ober-Emsium (Ems-Quarzit).

Sartenaerirhynchus* cf. *frontecostatus (Drevermann, 1902); Material: 2 Stk VK mit Aabdr, 1 Stk DK; Taf. 6: 8, 9.

Beschreibung und Diskussion: Die Länge des Muskelkomplexes zwischen Apex und dem *paries geniculatus* beträgt bei *Sartenaerirhynchus antiquus* (Schnur 1853) oft >50 %, bei *S. frontecostatus* ungefähr 50 %, wie bei der vorliegenden VK. Charakteristisch für *S. antiquus* sind die auf dem Stk scharfe Seitenkante der deutlich konkaven Seitenteile der Klappe, bei *S. frontecostatus* ragen die "Seitenkanten nicht oder nur wenig zinkenförmig vor" (Drevermann 1902). Auch die Seitenteile erscheinen weniger oder nicht konkav. Beide Merkmale treffen auf die vorliegende Klappe zu. Für eine klare taxonomische Zuordnung, wären weitere Funde zum Vergleich wünschenswert. Wahrscheinlich hat sich *S. antiquus* aus *S. frontecostatus* entwickelt. Sichere Nachweise von *S. antiquus* liegen erst ab dem mittleren Unter-Emsium vor (siehe Jansen 2016, Fig. 2). Eine Zuordnung der vorliegenden VK zu *S. ? eifeliensis* (Drevermann, 1902) oder *S. ? peregrinus* (Drevermann, 1902) lässt sich ausschließen, da beide Spezies einen kürzen Muskelkomplex aufweisen.

Stratigraphische Verbreitung von *S. frontecostatus* (nach Jansen 2016, Fig. 2) vom mittleren bis zum oberen Siegenium.

Athyris undata (Defrance, 1828); Material: 1 doppelklappiger Stk mit Aabdr, 5 doppelklappige Stk, 1 Stk DK; 1 Stk VK mit Aabdr, 15 Stk VK; Taf. 6: 10-12.

Beschreibung und Diskussion: Fuchs (1915: 27-28); Wolf (1930: 76-77). Durch eingehende Untersuchungen von Wolf (1930: 76-78, Taf. 3) kann davon ausgegangen werden, dass *Athyris caeraesana* (Steininger, 1853), *Athyris globula* Assmann 1910, *Athyris avirostris* (Krantz, 1857) intraspezifische Variationen von *Athyris undata* darstellen und als Synonyma einzuordnen sind.

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich Ober-Emsium.

Torosospirifer crassicosta crassicosta (Scupin, 1900), Material: 3 DK, 16 Stk VK, 7 VK mit Aabdr; Taf.7: 1-3.

Beschreibung und Diskussion: Solle (1971: 60-63). *T. crassicosta crassicosta* besitzt 10-12 kräftige Rippen, auf dem Stk meist 9-10. Zahnstützen relativ kurz ca. ⅓ bis maximal ½ der Gehäuselänge.

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich oberes Unter-Emsium.

Euryspirifer assimilis assimilis (Fuchs, 1915); Material: 3 DK, 2 Stk DK mit Aabdr, 3 VK, 2 VK-Fragment; Taf.7: 4-6.

Beschreibung und Diskussion: Fuchs (1915: 22); Jansen (2001: 220); Mittmeyer (2008: 201). Der wesentlichste Unterschied zu dem etwas jüngeren *Euryspirifer dunensis* (Kayser, 1889) besteht in der Zahl der Rippen. So beträgt bei *E. dunensis* die Rippen-Zahl auf der äußeren Schalen-Oberfläche 15 bis 22 pro Flanke, auf dem Stk 13 bis 20 pro Flanke. Bei *E. assimilis assimilis* beträgt die Rippen-Zahl auf der äußeren Schalen-Oberfläche nur 9 bis 11 pro Flanke, auf dem Stk 8 bis 10 pro Flanke. Weitere Unter-Arten von *E. assimilis* besitzen auf dem Stk 12 oder mehr Rippen.

Stratigraphische Verbreitung: Ulmen-Unterstufe, unteres Unter-Emsium. *E. assimilis assimilis* kann als Leitfossil für die Ulmen-Unterstufe angesehen werden (Mittmeyer 2008: 162).

***Arduspirifer*? sp.**; Material: 1 Stk VK; Taf.7: 7.

Beschreibung und Diskussion: Unklarheit besteht bei einem Spiriferiden unter der Sammlungsnummer MnhnL EIA 407, der hier vergrößert abgebildet wird. Wir betrachten ihn vorerst als *Arduspirifer* sp. mit Fragezeichen, wegen des sehr schwach angelegten Muskelzapfens. Abzugrenzen wäre *Alatiformia* Struve, 1963. Mittmeyer (2008: 188) listet eine *A.* cf. *alatiformis* aus den Eckfeld-Schichten (Ulmen-Unterstufe), also dem untersten Teil des Unter-Emsium auf. Sie ist aber weder abgebildet noch beschrieben. *A. alatiformis* (Drevermann, 1907) zeigt zu unserem Exemplar gewisse Ähnlichkeiten, unterscheidet sich aber durch den über den Schlossrand ragenden Muskelzapfen und den schmaleren Sinus (vgl. Struve 1964: Abb. 20, Taf. 31). Erschwerend kommt bei dem Stück EIA 407 hinzu, dass der Bereich der Area nicht einsehbar ist. Generell besitzt *Alatiformia* einen sich stärker nach vorn verbreiternden Sinus mit kantigen Sinusrippen. *A. affinis* (Fuchs, 1915) aus dem Unter-Emsium des Hunsrückschiefers zeigt zwischen den stark gespreizten Zahnstützen (bei unserem Stück nur schwach gespreizt) zwei kantige Sinusgrenzrippen (bei unserem Stück nur eine gerundete Sinusgrenzrippe). *A. affinis* hat eine deutlich proportional kürzere VK als unser Exemplar.

Arduspirifer arduennensis* cf. *initiator Mittmeyer, 2008; Material: 1 Stk VK; Taf.7: 8.

Beschreibung und Diskussion der Unterart: Mittmeyer (2008: 202).

Stratigraphische Verbreitung: Ulmen-Unterstufe, unteres Unter-Emsium.

Incertia incertissima (Godefroid, Stainier & Trost, 2002); Material: 1 Stk DK; Taf.7: 9.

Beschreibung und Diskussion: Godefroid et al. (2002: 35); Mittmeyer (2008: 202).

Stratigraphische Verbreitung: Ulmen-Unterstufe, unteres Unter-Emsium bis einschließlich Basis Laubach-Unterstufe, unteres Ober-Emsium,

Incertia subincertissima Mittmeyer, 2008; Material: 1 Stk DK; Taf.7: 10.

Beschreibung und Diskussion: Mittmeyer (2008: 202; Taf. 1 Fig. 15): "Gegenüber der etwas kleineren *incertissima* zeigt *subincertissima* leicht verbreiterten Umriss und dementsprechend mehr Rippen (ZR um 22, bei *incertissima* 16 bis 18) sowie häufiger spitz endende Flügel. Die Zahnstützen schneiden bei *subincertissima* normalerweise zwischen der 2. und 3., seltener zwischen der 3. und 4. Rippe ein." (ZR = Rippenzahl pro Flanke).

Stratigraphische Verbreitung: Ulmen-Unterstufe, unteres Unter-Emsium.

Cyrtina heteroclita (Defrance, 1828); Material: 1 Stk VK; Taf.7: 11.

Beschreibung und Diskussion: Dahmer (1915: 228-229); Maillieux (1932: 55-59, Taf. 2 Fig. 15, 15a; 1941: 55). *Cyrtina* ist eine schlecht untersuchte Formen-Gruppe. Der Typus von *heteroclita* Defrance, 1828 besitzt angeblich auf jeder Flanke drei Rippen bzw. Falten. Ihre weltweite Verbreitung (siehe Maillieux 1932: 59) von Asien bis Spanien, sowie ihre riesige stratigraphische Verbreitung vom mittleren Siegenium bis zum Frasnium (ibidem) sind a priori anzuzweifeln.

Meganteris ovata Maurer, 1879; Material: 3 Stk DK; 4 Stk VK; Taf.7: 12a,b, 13, 14.

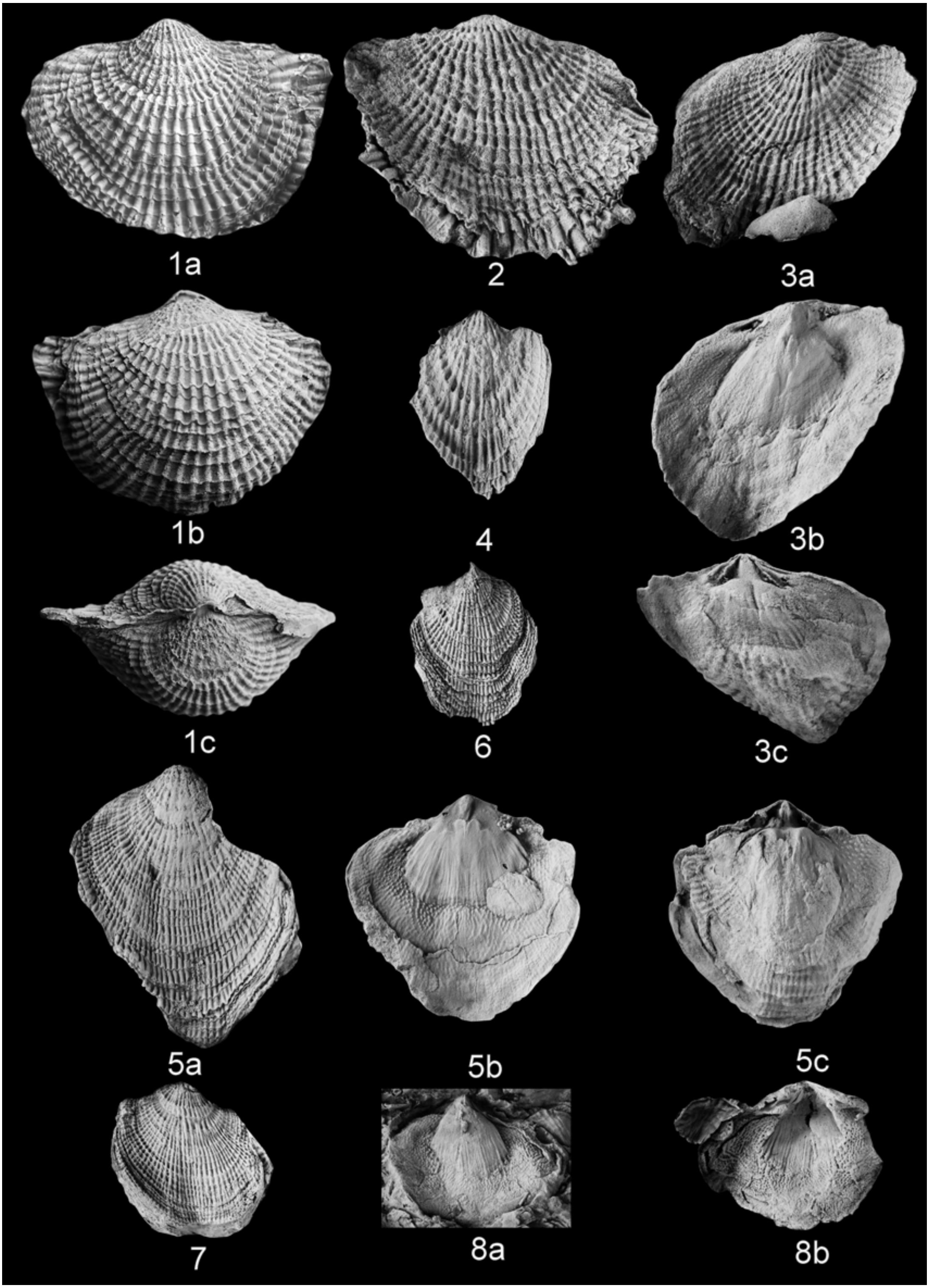
Beschreibung und Diskussion: Wolf (1930: 82); Dahmer (1934: 78); García-Alcalde (2013: 46, Figs. 1-2, 11, 21-27, Tab. 2). Er weist auf die Revisionsnotwendigkeit von *Meganteris ovata* Maurer hin.

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich mittleres Ober-Emsium.

Anoplotheca venusta (Schnur, 1853); Material: 3 doppelklappige Stk, 3 Stk DK; 7 Stk VK; Taf. 8: 1a, b, 2-4.

Beschreibung und Diskussion: Dahmer (1931: 101-102). Schnurs Stücke (1853: 180, Taf. 24 Fig. 3a, 3b) stammen aus der "Grauwacke zu Hontheim bei Prüm und zu Daun" und dürften unseres Erachtens aus dem mittleren Unter-Emsium stammen. Im Vergleich dazu, sind die uns zahlreich vorliegenden oberemsischen Exemplare größer und zeigen auf dem Stk der VK morphologische Unterschiede bezüglich des Diductor-Feldes und den Eindrücken der Vascula media. Dass es sich hier um eine andere Unterart bzw. andere Art handelt ist offensichtlich.

Stratigraphische Verbreitung: mittleres Siegenium bis einschließlich oberes Unter-Emsium.


1a
2
3a
1b
4
3b
1c
6
3c
5a
5b
5c
7
8a
8b

Globithyris*? *confluentina (Fuchs, 1907); Material: 2 DK; Taf. 8: 5, 6.

Beschreibung und Diskussion: Fuchs (1907: 43, Taf. 7, 8); Solle (1976: 195).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich unteres Ober-Emsium (Berlé-Quarzit).

Neopaulinella* ? cf. *guerangeri (de Verneuil, 1850); Material: 1 Stk VK mit Aabdr, 2 Stk VK; Taf. 8: 7.

Beschreibung und Diskussion: Kayser (1889: 294, Taf. 14 Fig. 4-7 (3?); Wolf (1930: 80-82); Solle (1976: 195); García-Alcalde (2013: 77-87).

Stratigraphische Verbreitung: unteres Unter-Emsium bis einschließlich unteres Ober-Emsium (Berlé-Quarzit).

Rhenorensselaeria demerathia Simpson, 1940; Material: 2 Stk DK, 1 DK-Fragment, 1 Stk VK; Taf. 8: 10, 11.

Beschreibung und Diskussion: Simpson (1940: 49-50). Hauptverbreitungsgebiet und Lokalisation der Erstbeschreibung liegen in der Südost- und Zentral-Eifel (Simpson 1940: 49-50). Aus Luxemburg wird das Vorhandensein dieser Spezies hiermit erstmalig gemeldet.

Wichtigste Unterschiede zu *Rhenorensselaeria strigiceps* (F. Roemer, 1844) sind die geringere Größe (*demerathia* nur bis 28 mm lang) und die geringere Zahl der Rippen (35 bis 50 bei *demerathia*, 50 bis 65 bei *strigiceps*), außerdem ist das Septum hinten nicht verdickt wie bei *strigiceps*. *Rhenorensselaeria propinqua* (Fuchs, 1907) ist eine adolescente Form von *strigiceps* und damit nach Simpson (1940: 46) ein jüngeres subjektives Synonym von *strigiceps*.

Stratigraphische Verbreitung: oberes Siegenium (Saxler-Schichten und Herdorf-Schichten).

Cryptonella rhenana (Drevermann, 1902): Material: 2 Stk DK, 2 Stk VK; Taf. 8: 8.

Beschreibung und Diskussion: Drevermann (1902: 98-99). García-Alcalde (2013: 77-87) stellte die neue

Tafel 1

1. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, Nahezu unverdrücktes, doppelklappig erhaltenes Exemplar, Breite 31,5 mm, MnhnL EIA 577. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **1a.** VK, Silikonabguss des Außenabdrucks, x 1,5, **1b.** DK, x 1,5, **1c.** Ansicht von posterior mit angedrücktem dorsalem Schnabel unter den Apex der VK, x 1,5.

2. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, VK eines großen Exemplars, x 1, Länge 31,3 mm, Breite 43,0 mm; nhmM, Fund Seibert 03.2005, PWL 2021/6746-LS. - Rittersturz-Formation, Vallendar-Gruppe, Unter-Emsium, Fundort Vallendar, Hang NE Pilgerkirche.

3. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, Doppelklappiges Exemplar, Länge 33,3 mm, Breite 40,0 mm; nhmM, Fund Seibert 03.2005, PWL 2021/6747-LS. - Rittersturz-Formation, Vallendar-Gruppe, Unter-Emsium, Fundort Vallendar, Hang NE Pilgerkirche. **3a.** VK, Silikonabguss des Außenabdrucks, x 1, **3b.** Innenabdruck der VK, x 1, **3c.** Innenabdruck der DK, x 1.

4. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, VK, seitlich verdrückt, x 1; Länge 26,2 mm, Breite 23,5 mm, nhmM, Fund Wenndorf 26.07.1978, PWL 2020/5596-LS. - Bornich-Formation, Ulmen-Gruppe, Unter-Emsium. Fundort St. Goarshausen, Galgenkopf an der Loreley (Locus typicus).

5. ***Atrypa*** (***Atrypa***) "***reticularis***" (Linnaeus, 1758), Doppelklappiges Exemplar, Länge 36,0 mm, Breite 36,8 mm; nhmM, Fund Wenndorf 1976, PWL 2020/5897-LS. - Laubach-Gruppe, Ober-Emsium. Fundort Allerheiligenberg bei Niederlahnstein. **5a.** VK, Silikonabguss, x 1, **5b.** Innenabdruck der VK mit großem Muskelfeld, x 1, **5c.** DK. Im Unterschied zu *A.* (*A.*) *lorana* zeigt *A.* (*A.*) *reticularis* dichtere und zahlreichere Rippen, x 1.

6. ***Atrypa*** (***Atrypa***) "***reticularis***" (Linnaeus, 1758), VK, Länge 22,0 mm, Breite 20,0 mm, x 1; nhmM, Fund Seibert 03.2016, PWL 2021/6758-LS. - Kieselgallenschiefer-Formation, obere Kondel-Gruppe. Fundort Heiligenroth bei Montabaur, Ober-Emsium.

7. ***Atrypa*** (***Atrypa***) "***reticularis***" (Linnaeus, 1758), VK, Länge 24,9 mm, Breite 25,5 mm, x 1; nhmM Fund Seibert 03.2016, PWL 2021/6757- LS. - Kieselgallenschiefer-Formation, obere Kondel-Gruppe. Fundort Heiligenroth bei Montabaur, Ober-Emsium.

8. ***Atrypa*** (***Atrypa***) "***reticularis***" (Linnaeus, 1758), Innenabdruck einer DK, gleiche Gesteinsplatte wie bei Fig. 7, Länge 21,8 mm, Breite 30,8 mm; nhmM, Fund Seibert 03.2016, PWL 2021/6757- LS. - Kieselgallenschiefer-Formation, obere Kondel-Gruppe. Fundort Heiligenroth bei Montabaur, Ober-Emsium. **8a.** Innenabdruck (Stk) mit konvexem Muskelfeld, x 1, **8b.** Gleiches Exemplar, Silikonabguss mit erhaltenen Cruralbasen, x 1.


1a


1b


1c


4


2


3


5


6


7


8


9


10


11a


11b


11c


11d


12

Gattung *Monsenella* auf, in die er, allerdings mit Bedenken, auch *C. rhenana* und *C. minor* Dahmer, 1931 einschloss. Seine Einschränkungen bezogen sich auf unzureichendes Material, so dass wir bis zur endgültigen Verifizierung des Sachverhaltes *rhenana* bei *Cryptonella* belassen.

Stratigraphische Verbreitung: Unter-Emsium bis einschließlich mittleres Ober-Emsium.

Tafel 2

1. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, doppelklappiger Stk; MnhnL EIA 577. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **1a.** Stk, Ansicht von ventral, x 1,1, Breite 28 mm. **1b.** Stk, Ansicht von dorsal, x 1,1, **1c.** Stk, Ansicht von posterior, x 1,1,

2. ***Atrypa* (*Atrypa*) *lorana*** Fuchs, 1915, Stk einer DK, Bildausschnitt zum Verdeutlichen der lobierten Zahnstützen, x 2,4, Bildbreite 19mm; MnhnL EIA 637. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

3. ***Merglia schwerdi*** (Drevermann, 1902), Stk einer juvenilen DK, Aufsicht, x 1,2, Breite 11 mm; MnhnL EIA 678. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

4. ***Petrocrania krautscheidensis*** Franke, 2012, Stk einer DK, Aufsicht, x 1, Breite 28 mm; MnhnL EIA 414. - Reideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

5. ***Petrocrania krautscheidensis*** Franke 2012, Stk einer DK, Aufsicht, x 1, Breite 26 mm; MnhnL EIA 319. - Reideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 5) bei Heiderscheid, Oesling, Luxemburg.

6. Craniidae gen. et sp. indet., Stk einer DK, Aufsicht, x 1,2, Breite19 mm; MnhnL EIA 679. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

7. ***Leptaena* sp.**, Stk einer VK, Aufsicht, x 1, Breite 33 mm; MnhnL EIA 681. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

8. ***Leptaena* sp.**, Stk einer DK, Aufsicht, x 1, Breite 34 mm; MnhnL EIA 682. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

9. ***Leptaena* sp.**, Stk einer DK, Aufsicht, x 1 Breite36mm; MnhnL EIA 683. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

10. ***Leptaena* sp.**, Stk einer VK, Aufsicht, x 1, Breite 23 mm; MnhnL EIA 684. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

11. ***Leptaenopyxis* cf. *kerfornei*** Racheboeuf, 1976, Stk einer DK; MnhnL EIA 685. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **11a.** Ansicht von posterodorsal, x 1, Breite 29 mm, **11b.** Ansicht von lateral, x 1, **11c.** Ansicht von anterior, x 1 , **11d.** Fragment des Außen-Abdruckes, x 1.

12. ***Leptaenopyxis* cf. *kerfornei*** Racheboeuf, 1976, Stk einer DK, Ansicht von posterodorsal, x 1, Breite 41 mm; MnhnL EIA 686. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.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Tafel 3

1. *Gigastropheodonta* sp. aff. *gigas* (M'Coy, 1852), Stk einer DK; MnhnL EIA 687. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **1a.** Aufsicht, x 1, Breite 46 mm, **1b.** Fragment des Außen-Abdruckes des gleichen Stückes, x 1.

2. *Leptostrophiella explanata* (Sowerby, 1842), Stk einer juvenilen VK; MnhnL EIA 688. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **2a.** Aufsicht, x 1, Breite 26 mm, **2b.** Außen-Abdruckes des gleichen Stückes, x 1.

3. *Leptostrophiella explanata* (Sowerby, 1842), Stk einer DK, Aufsicht, x 1, Breite 48 mm; MnhnL EIA 689. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

4. *Leptostrophiella explanata* (Sowerby, 1842), Stk einer VK, Aufsicht, x 1, Länge 48,5 mm; MnhnL EIA 690. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

5. *Pseudoleptostrophia dahmeri* (Rösler, 1954), Stk einer DK, Aufsicht, x 1, Breite 38 mm; MnhnL EIA 691. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. *Leptostrophiella explanata* (Sowerby, 1842) rechts und ***Pseudoleptostrophia dahmeri*** (Rösler, 1954) links, Platte mit zwei übereinander liegender Stk von VK, Aufsicht, x 0,8, Länge beider Klappen 76 mm; MnhnL EIA 402. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.


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Tafel 4

1. *Gibbodouvillina* sp., Stk einer VK; Aufsicht, x 1, Breite 32 mm; MnhnL EIA 570. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

2. *Gibbodouvillina* sp., Stk einer VK, Ansicht von posterior, x 1, Breite 28,5 mm; MnhnL EIA 692. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

3. *Gibbodouvillina* sp., Stk einer juvenilen VK; MnhnL EIA 693. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. 3a. Aufsicht, x 2, Breite 7,5 mm, 3b. Außen-Abdruckes des gleichen Stückes, x 2.

4. *Gibbodouvillina taeniolata* (Sandberger & Sandberger, 1856), Stk einer VK zum Vergleich, Aufsicht, x 1, Breite 29 mm; Coll. C. Franke KRA 1-690. - Wiltz-Schichten, unteres oder mittleres Ober-Emsium; Fundort: Krautscheid, West-Eifel, Rheinisches Schiefergebirge, Deutschland.

5. *Gibbodouvillina* sp., Stk einer juvenilen DK, Aufsicht, x 1,3, Breite 16,4 mm; MnhnL EIA 593. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

6. *Gibbodouvillina* sp., Stk einer VK, Aufsicht, x 1,2, Breite 21 mm; MnhnL EIA 694. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

7. *Fascistropheodonta sedgwicki* (d´Archiac & de Verneuil, 1842), Stk einer DK, Aufsicht, x 1, Breite 40 mm; MnhnL EIA 109. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

8. *Platyorthis circularis circularis* (Sowerby, 1842), Stk einer DK; MnhnL EIA 357. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 5) bei Heiderscheid, Oesling, Luxemburg. **8a.** Aufsicht, x 1, Breite 36 mm, **8b.** Außen-Abdruck des gleichen Stückes.

9. *Platyorthis nocheri* (Fuchs, 1915), Stk einer VK, Aufsicht, x 1, Breite 19 mm; MnhnL EIA 695. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

10. *Platyorthis circularis circularis* (Sowerby, 1842), Stk einer VK; MnhnL EIA 141. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **10a.** Aufsicht, x 1, Breite 17 mm, **10b.** Ansicht von posteroventral x 1,2.

11. *Platyorthis nocheri* (Fuchs, 1915), Stk einer juvenilen VK; MnhnL EIA 512. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **11a.** Aufsicht, x 1, Breite 18 mm, **11b.** Ansicht von posteroventral x 1,2. Im Unterschied zu *P. circularis circularis* erkennt man gut die unverfüllte ventrale laterale Apikal-Höhle.

12. *Rhenoschizophoria provulvaria* (Maurer, 1886), Stk einer VK, Aufsicht, x 1, Breite 29 mm; MnhnL SGE 172. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

13. *Rhenoschizophoria provulvaria* (Maurer, 1886), Stk einer etwas von lateral gestauchten VK, Aufsicht, x 1, Breite 23 mm; MnhnL EIA 581a. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

14. *Rhenoschizophoria provulvaria* (Maurer, 1886), Stk einer verdrückten DK, Aufsicht, x 1, Breite 18 mm; MnhnL EIA 582. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

15. *Protocortezorthis* ? sp., Stk einer VK, Aufsicht, x 1,5, Breite 18,5 mm; MnhnL EIA 336. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.


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Tafel 5

1. ***Plebejochonetes semiradiatus*** (Sowerby, 1842), mehrere Stk von VK und DK, Aufsicht, x 0,9, Breite der Platte 90 mm; MnhnL EIA 371. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 4) bei Heiderscheid, Oesling, Luxemburg.

2. ***Plebejochonetes unkelensis*** (Dahmer, 1936); Stk einer VK, Aufsicht, x 1, Breite 14 mm; MnhnL EIA 696. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

3. ***Loreleiella extensa*** (Kayser, 1889), Stk einer VK; MnhnL EIA 422. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **3a.** Aufsicht, x, 1,4, Breite 20 mm, **3b.** Außen-Abdruckes des gleichen Stückes.

4. ***Loreleiella extensa*** (Kayser, 1889), Stk-Fragment einer juvenilen DK, Aufsicht, x 1,5 Breite 16 mm; MnhnL EIA 697. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

5. ***Loreleiella dilatata*** (Roemer, 1844), Stk-Fragment einer VK; MnhnL EIA 141. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **5a.** Aufsicht, x 1,1, Breite 28 mm, **5b.** Ansicht von posterior, x 1,1.

6. ***Tropidoleptus rhenanus*** Frech, 1897, Stk einer DK; MnhnL EIA 405. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **6a.** Aufsicht, x 1,1, Breite 32 mm, **6b.** Außen-Abdruck des gleichen Stückes.

7. ***Tropidoleptus rhenanus*** Frech, 1897, Stk einer VK; MnhnL EIA 411. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **7a.** Aufsicht, x 1, Breite 18 mm, **7b.** Außen-Abdruck des gleichen Stückes.

8. ***Oligoptycherhynchus prodaleidensis*** Mittmeyer, 2008, Stk einer VK, Aufsicht, x 1,5, Breite 13mm; MnhnL EIA 557. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

9. ***Oligoptycherhynchus prodaleidensis*** Mittmeyer, 2008, doppelklappiger Stk; MnhnL EIA 364. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 5) bei Heiderscheid, Oesling, Luxemburg. **9a.** Ansicht von ventral, x 1,9, Breite 15,4mm, 9b. Ansicht von dorsal, x 1,9.

10. ***Oligoptycherhynchus prodaleidensis*** Mittmeyer, 2008, Stk einer DK, Aufsicht, x 1,7, Breite 11mm; MnhnL EIA 559. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

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Tafel 6

1. ***Oligoptycherhynchus* aff. *daleidensis*** (Roemer, 1844), Stk-Fragment einer VK, Aufsicht, x 2, Breite 16 mm; MnhnL EIA 564. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

2. ***Oligoptycherhynchus* aff. *daleidensis*** (Roemer, 1844), Stk einer VK, Aufsicht, x 1,8, Breite 9,5mm; MnhnL EIA 560. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

3. ***Oligoptycherhynchus* aff. *daleidensis*** (Roemer, 1844), Stk einer VK, Aufsicht, x 1,7, Breite 12mm; MnhnL EIA 561. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

4. ***Oligoptycherhynchus* aff. *daleidensis*** (Roemer, 1844), Stk einer DK, Aufsicht, x 1,8, Breite 17mm; MnhnL EIA 425. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

5. ***Oligoptycherhynchus* aff. *daleidensis*** (Roemer, 1844), Stk einer DK, Aufsicht, x 2,2, Breite 10mm; MnhnL EIA 562. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. ***Straelenia dunensis*** (Drevermann, 1902), Stk einer VK, Aufsicht, x 1,4, Länge 27 mm; MnhnL EIA 523. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

7. ***Straelenia dunensis*** (Drevermann, 1902), Stk einer DK, Aufsicht, x 1,3, Breite 24 mm; MnhnL EIA 568. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

8. ***Sartenaerirhynchus*** cf. ***frontecostatus*** (Drevermann, 1902); Stk einer VK, Aufsicht, x 1,5, Breite 19 mm; MnhnL EIA 522. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

9. ***Sartenaerirhynchus*** cf. ***frontecostatus*** (Drevermann, 1902); Stk einer DK, Aufsicht, x 1,5, Breite 17,5 mm; MnhnL EIA 5402. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

10. ***Athyris undata*** (Defrance, 1828), doppelklappiger Stk; MnhnL EIA 567. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **10a.** Aufsicht von ventral, x 1, Breite 14 mm, **10b.** Aufsicht von dorsal, x 1.

11. ***Athyris undata*** (Defrance, 1828), doppelklappiger Stk; MnhnL EIA 566. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. **11a.** Ansicht von ventral, x 2, Breite 14 mm, **11b.** Ansicht von dorsal, x 2, **11c.** Ansicht von posterior, x 2.

12. ***Athyris undata*** (Defrance, 1828), doppelklappiger Stk; MnhnL EIA 565. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **12a.** Ansicht von ventral, x 1,5, Breite 16 mm, **12b.** Ansicht von dorsal, x 1,5, **12c.** Ansicht von posterior, x 1,5.


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Tafel 7

1. ***Torosospirifer crassicosta crassicosta*** (Scupin, 1900), Stk einer VK, Aufsicht, x 1, Breite 41 mm; MnhnL EIA 526. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

2. ***Torosospirifer crassicosta crassicosta*** (Scupin, 1900), Stk einer juvenilen VK, Aufsicht, x 1,3, Breite 20 mm; MnhnL EIA 545. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

3. ***Torosospirifer crassicosta crassicosta*** (Scupin, 1900), Stk einer verdrückten DK, Aufsicht, x 1, Breite 33 mm; MnhnL EIA 532. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

4. ***Euryspirifer assimilis assimilis*** (Fuchs, 1915), Stk-Fragment einer VK, Aufsicht, x 1, Breite 48 mm; MnhnL EIA 416. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

5. ***Euryspirifer assimilis assimilis*** (Fuchs, 1915), Stk einer DK, Aufsicht, x 1, Breite 54 mm; MnhnL EIA 698. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. ***Euryspirifer assimilis assimilis*** (Fuchs, 1915), Stk-Fragment einer juvenilen VK, Aufsicht, x 1, Breite 18 mm; MnhnL EIA 699. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 5) bei Heiderscheid, Oesling, Luxemburg.

7. ***Arduspirifer*? sp.**, Stk-Fragment einer VK, Aufsicht, x 1, Breite 26 mm; MnhnL EIA 407. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

8. ***Arduspirifer arduennensis* cf. *initiator*** Mittmeyer, 2008, Stk-Fragment einer VK, Aufsicht, x 1,2, Breite 14,6 mm; MnhnL EIA 569. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

9. ***Incertia incertissima*** (Godefroid, Stainier & Trost, 2002), Stk-Fragment einer flach gedrückten VK, Aufsicht, x 1,1 Breite 24 mm; MnhnL EIA 543. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

10. ***Incertia subincertissima*** Mittmeyer, 2008, Silikon-Abdruck einer VK, Aufsicht, x 1, Breite 41 mm; MnhnL EIA 366. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

11. ***Cyrtina heteroclita*** (Defrance, 1828), Stk einer VK, Aufsicht, x 2, Breite 9,2 mm; MnhnL EIA 141. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

12. ***Meganteris ovata*** Maurer, 1879, Stk einer VK; MnhnL EIA 521. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg. **12a.** Aufsicht, x 1,2, Breite 32 mm, **12b.** Ansicht von posterior, Bildausschnitt x 1,2.

13. ***Meganteris ovata*** Maurer, 1879, Stk einer DK, Aufsicht, x 1, Breite 34 mm; MnhnL EIA 131. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

14. ***Meganteris ovata*** Maurer, 1879, Stk einer DK, Aufsicht, x 1,5, Breite 27 mm; MnhnL EIA 570. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.


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Tafel 8

1. ***Anoplotheca venusta*** (Schnur, 1853), doppelklappiger Stk; MnhnL EIA 573. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg. 1a. Ansicht, von ventral, x 2, Breite 7,2 mm, 1b. Ansicht, von dorsal, x 2.

2. ***Anoplotheca venusta*** (Schnur, 1853), Stk, Außen-Abdruck einer DK, Aufsicht, x 2, Breite 8 mm; MnhnL EIA 575. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

3. ***Anoplotheca venusta*** (Schnur, 1853), Stk einer VK, Aufsicht, x 2, Breite 9,5 mm; MnhnL EIA 574. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 1) bei Heiderscheid, Oesling, Luxemburg.

4. ***Anoplotheca* cf. *venusta*** (Schnur, 1853), Stk zweier VKn zum Vergleich, x 2, Bildbreite 21 mm; Coll. C. Franke KRA 1-618. - Wiltz-Schichten, unteres oder mittleres Ober-Emsium; Fundort: Krautscheid, West-Eifel, Rheinisches Schiefergebirge, Deutschland.

5. ***Globithyris*? *confluentina*** (Fuchs, 1907); Stk einer VK, Aufsicht, x 2, Breite 15 mm; MnhnL EIA 417. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

6. ***Globithyris*? *confluentina*** (Fuchs, 1907); Stk einer VK, Aufsicht, x 2, Breite 13 mm; MnhnL EIA 417. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

7. ***Neopaulinella* ? cf. *guerangeri*** (De Verneuil, 1850), Stk einer verdrückten VK, Aufsicht, x 1,2, Breite 25 mm; MnhnL EIA 547. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

8. ***Cryptonella rhenana*** (Drevermann, 1902), Stk einer juvenilen VK, Aufsicht, x 2, Breite 12 mm; MnhnL EIA 577. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

9. ***Cryptonella* sp.**, Stk einer DK, Aufsicht, x 2, Breite 12 mm; MnhnL EIA 576. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

10. ***Rhenorensselaeria demerathia*** Simpson, 1940, Stk-Fragment einer VK, Aufsicht, x 1, Breite 19 mm; MnhnL EIA 572. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

11. ***Rhenorensselaeria demerathia*** Simpson, 1940, Stk einer DK, Aufsicht, x 1, Breite 25 mm; MnhnL EIA 571. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

12. Brachiopoda fam. et gen. et sp. indet., Stk einer VK, Aufsicht, x 1, Breite 26 mm; MnhnL EIA 141. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

13. Brachiopoda fam. et gen. et sp. indet., Stk-Fragment einer VK, Aufsicht, x 1,6, Breite 12 mm; MnhnL EIA 580. - Réideschbaach-Schichten, unteres Unter-Emsium, Fundort Réideschbaach (REI 2) bei Heiderscheid, Oesling, Luxemburg.

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Crinoidea

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Schlüsselwörter: Echinodermata, Unterdevon, Réideschbaach, Emsium, Luxemburg.

Zusammenfassung

In dem Material fanden sich fast ausschließlich vereinzelte Stiel-Glieder, die nicht zwingend darauf hinweisen, dass die Crinoiden in unmittelbarer Nähe gelebt haben, sondern einen etwas größeren Frachtweg aufweisen könnten. Nur vier Nachweise lassen sich zumindest auf Gattungs-Niveau, zwei davon auf Art-Niveau zuordnen. Dazu gehören *Botryocrinus montisguyonensis* Delpey, 1942, *Culicocrinus inventriosus* Schmidt, 1941, *Ctenocrinus* sp. und *Diamenocrinus* sp. Vertreten sind weiterhin drei parataxonomische Genera: *Laudonomphalus*, *Marettocrinus* und *Amurocrinus*. Mit anzunehmender Sicherheit sind weitere Arten zu erwarten.

Keywords: Echinodermata, Lower Devonian, Réideschbaach, Emsian, Luxembourg.

Abstract

The material contained almost exclusively isolated columnals, which do not necessarily indicate that the crinoids lived in the immediate vicinity, but could have travelled a somewhat longer distance. Only four specimens can be assigned at least to genus level, two of them to species level. These include *Botryocrinus montisguyonensis* Delpey, 1942, *Culicocrinus inventriosus* Schmidt, 1941, *Ctenocrinus* sp. and *Diamenocrinus* sp. Three parataxonomic genera are also represented: *Laudonomphalus*, *Marettocrinus* and *Amurocrinus*. Further species are to be expected with probable certainty.

Mots-clés : Echinodermata, Dévonien inférieur, Réideschbaach, Emsien, Luxembourg.

Résumé

Le matériel contient presque exclusivement des articles de tige isolés, qui n'indiquent pas nécessairement que les crinoïdes vivaient à proximité immédiate, mais qui pourraient indiquer un trajet de transport un peu plus important. Seules quatre preuves peuvent être attribuées au moins au niveau du genre, dont deux au niveau de l'espèce. Il s'agit de *Botryocrinus montisguyonensis* Delpey, 1942, *Culicocrinus inventriosus* Schmidt, 1941, *Ctenocrinus* sp. et *Diamenocrinus* sp. Trois genres parataxonomiques sont également représentés : *Laudonomphalus*, *Marettocrinus* et *Amurocrinus*. On peut s'attendre à la présence d'autres espèces.

1 Abkürzungen und Definitionen

MnhnL - Sammlung des Musée national d´histoire naturelle Luxembourg.

Réideschbaach-Schichten – diese Bezeichnung wird hier als informeller Begriff für die Siltsteine mit Konkretionen und quarzitischen Sandsteine vom Réideschbaach benutzt. Sie entsprechen dem unteren Teil der Oberen Tonschiefer-Abfolge bei Lunkenheimer (Basse & Franke 2006: 9, Tab. 1).

REI 1 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'49.42"N, 6°00'27.05" O.

REI 2 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'54.81"N, 6°00'19.40" O.

REI 5 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:

49°52'47.96"N, 6°00'36.55" O.

2 Taxonomische Arten

Botryocrinus montisguyonensis Delpey, 1942; Material: 3 Stiel-Glieder; (Taf 1: 1, 2).

***Ctenocrinus* sp.**; Material: 5 Stiel-Glieder (Taf. 1: 3, 4, 5).

***Culicocrinus inventriosus* n. subsp.** Schmidt, 1941; Material: 1 Abdruck eines Kelch-Fragmentes mit Basalia und abwärts gerichteten Stacheln (EIA 452) (Breite 6,2mm), 9 Stiel-Glieder, 1 Stiel-Abschnitt; (Taf. 1: 6, 7).

***Diamenocrinus* sp.**; Material: 1 Stiel-Glieder, 2 isolierte Areolen, 1 Stiel-Abschnitt; (Taf. 1: 8, 9, 10).

3 Parataxonomische Arten

***Laudonomphalus* sp.**; Material: 3 Stiel-Glieder; (Taf. 1: 11, 12). Es ist sehr wahrscheinlich, dass *Laudonomphalus*-Stiel-Glieder zu *Ctenocrinus* Bronn, 1840 gehören.

***Marettocrinus* sp.**; Material: 2 Stiel-Glieder; (Taf. 1: 13).

***Amurocrinus* sp.**; Material: 1 Stiel-Glieder; (Taf. 1: 14).

4 Diskussion

Für devonische Crinoiden mit großer geographischer und stratigraphischer Reichweite ergibt sich immer deutlicher ein taxonomisches Problem. Anhand von *Botryocrinus montisguyonensis* Delpey, 1942 soll dieses erläutert werden. Sie wurde nachgewiesen vom oberen Pragium bis zum mittleren

Tafel 1

1. *Botryocrinus montisguyonensis* Delpey, 1942, Abdruck eines Stielgliedes x 2,8; MnhnL EIA 577. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

2. *Botryocrinus montisguyonensis* Delpey, 1942, Abdruck eines Stielgliedes x 3; MnhnL EIA 671. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

3. *Ctenocrinus* sp., Stielglied-Abdrücke, Handstück x 0,8; MnhnL EIA 361. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 5), Oesling, Luxemburg.

4. *Ctenocrinus* sp., Abdruck eines Stielgliedes, x 2,8; MnhnL EIA 672. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

5. *Ctenocrinus* sp., Abdruck eines Stielgliedes, x 3; MnhnL EIA 673. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

6. *Culicocrinus inventriosus* n. ssp. Schmidt, 1941, Abdruck eines Kelch-Fragments mit Basalia und abwärts gerichteten Stachel- Ansätzen x 4,3; MnhnL EIA 452. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

7. *Culicocrinus* sp., Abdruck eines Stielgliedes, x 2,5; MnhnL EIA 674. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

8. *Diamenocrinus* sp., Abdruck eines Stielglied-Fragments, isolierte Areola x 2; MnhnL EIA 389. - Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 2), Oesling, Luxemburg.

9. *Diamenocrinus* sp., Abdruck eines Stielglieds, x 1,3; MnhnL EIA 328. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 2), Oesling, Luxemburg.

10. *Diamenocrinus* sp., Abdruck eines Stielglied-Fragments mit herausgewitterter isolierter Areola x 2,2; MnhnL EIA 373. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 5), Oesling, Luxemburg.

11. *Laudonomphalus*? sp., Abdruck eines Stielglieds, x 2; MnhnL EIA 675 – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.

12. *Laudonomphalus*? sp., Silikon-Abdruck eines Stielglieds, x 1,5; MnhnL EIA 358. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 5), Oesling, Luxemburg.

13. *Marettocrinus* sp., Abdruck eines Stielglieds, x 1,5; MnhnL EIA 676. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort: Réideschbaach bei Heiderscheid (REI 2), Oesling, Luxemburg.

14. *Amurocrinus* sp., Abdruck eines Stielglieds, x 3; MnhnL EIA 677. – Réideschbaach-Schichten, unteres Unter-Emsium. Fundort : Réideschbaach bei Heiderscheid (REI 1), Oesling, Luxemburg.


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Ober-Emsium von Baetica, Cantabria, Armorica, Normandie, Ardennen, Oesling und Eifel (siehe Le Menn 1985: 86-87; Franke 2012: 13-15). Neben dem Vorkommen in den ober-emsischen Wiltz-Schichten (Franke, ibidem) fanden wir dieses Taxon auch in den tiefen unter-emsischen Schichten vom Réideschbaach.

Meinen Untersuchungen ober-emsischer Crinoida zufolge, konnte ich belegen, dass alle eindeutig determinierten Spezies nicht die Grenze Unter-Emsium / Ober-Emsium überschritten hatten und damit wertvolle biostratigraphische Leitformen darstellen. Es wird an dieser Stelle sehr deutlich, dass der taxonomischen Zuordnung von morphologischen Charakteristika einzelner Stielglieder Grenzen gesetzt sind. Ohne dazugehörige Krone, bzw. Kelch und Brachialia sollte deshalb eine Zuweisung nur auf Gattungsebene erfolgen. Gerade bei parataxonomisch definierten Spezies empfiehlt es sich, diese nur stratigraphisch gleichaltrigen Formen zuzuschreiben.

Vergleichsmöglichkeiten sind rare. Gut bearbeitet sind die Crinoiden aus dem Armorikanischen Massiv (Le Menn et al. (1976), Le Menn 1981, 1985, 1987). Aus paläogeographischer Sicht befinden sich deren unterdevonischen Ablagerungsräume in Bezug auf das Ardenno-Rheinische Massiv allerdings in ziemlich weiter Entfernung, was den Grad spezifischer Übereinstimmungen wesentlich reduzieren kann. Ebenfalls gut bearbeitet sind die unteremsischen Ablagerungen des Hunsrückschiefers (Schmidt 1934, 1941). Vergleiche sind hier relativ ausgeschlossen, da einzelne Stielglieder kaum vorkommen, und wenn, sind sie in der Regel durch den schlechten Zustand nicht auswertbar.

Anders verhält es sich bei dem zweiten Teil der Arbeit von Schmidt (1941), in dem eine Reihe unteremsischer Crinoiden beschrieben werden, allerdings nur selten in Bezug auf ihre möglichen Stielglieder. Dieser interessante Gesichtspunkt ist derzeit absolut unterrepräsentiert und bietet ein spannendes Untersuchungsfeld. Ich halte es deshalb für sinnvoll, alle eindeutigen Nachweise zu veröffentlichen und für zukünftige Forschungen zugänglich zu machen.

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A phyllocarid crustacean (Phyllocarida: Archaeostraca) from the Lower Devonian (lower Emsian) of Réideschbaach in Luxembourg, with emphasis on cuticle ornamentation

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Schlüsselwörter: Phyllocarida, Rhinocarididae, Devon, Emsium, Ornament, Réideschbaach, Luxemburg.

Zusammenfassung

Ein fragmentierter phyllocarider Krebs aus dem unteren Emsium von Réideschbaach bei Heiderscheid in Luxemburg wird kurz beschrieben und abgebildet. Basierend auf Merkmalen der Verzierung der Kutikula wird das Fossil vorläufig der Familie Rhinocarididae zugeordnet und mit einigem Vorbehalt zu der Gattung *Nahecaris* gestellt. Die starke Fragmentierung des Krebspanzers, die bereits vor der Einbettung stattgefunden hat, spricht dafür, dass es sich um einen möglichen Fraßrest handelt.

Keywords: Phyllocarida, Rhinocarididae, Devonian, Emsian, ornament, Réideschbaach, Luxembourg.

Abstract

A fragmented phyllocarid crustacean from the lower Emsian of Réideschbaach near Heiderscheid/Luxembourg is briefly described and figured. Based on features of carapace ornamentation the fossil is tentatively placed in the family Rhinocarididae and assigned with reservations to the genus *Nahecaris*. The strong fragmentation of the carapace, which took part prior to burial, suggests that this specimen could represent the remains of a prey.

Mots clés: Phyllocarida, Rhinocarididae, Devonien, Emsien, ornament, Réideschbaach, Luxembourg.

Résumé

Un crustacé phyllocaridé fragmenté de l'Emsien inférieur de Réideschbaach près de Heiderscheid/Luxembourg est brièvement décrit et figuré. Basé sur les caractéristiques de l'ornementation de la carapace, le fossile est provisoirement placé dans la famille des Rhinocarididae et assigné avec precaution dans le genre *Nahecaris*. La forte fragmentation de la carapace, qui s'est produite avant l'enterrement, suggère que ce spécimen pourrait représenter un reste de proie.

1 Introduction

Archaeostracan phyllocarids constitute the exclusively Palaeozoic sister group of extant leptostracan crustaceans (Wolfe et al. 2016), but are probably paraphyletic (Hegna et al. 2020). Phyllocarids are widespread in the Rhenish lower Devonian and adjacent areas (Gürich 1929; Jux 1985, 1991; Hahn 1990; Brauckmann et al. 2002; Hellemond et al. 2020; Poschmann 2021 and references therein) with eight taxa of phyllocarids having hitherto been named from the Rhenish lower Devonian (Poschmann 2021). However, complete specimens are rare and confined to very few Fossil-Lagerstätten, such as the celebrated lower Emsian Hunsrück Slate (e.g., Bergström et al. 1987, 1989; Bergmann & Rust 2014; Poschmann et al. 2018).

Phyllocarids from the Devonian (Emsian) of Luxembourg have already been described by Brauckmann et al. (2002) and were attributed to *Nahecaris frankei* Brauckmann et al., 2002. Here we report a phyllocarid from the lower Emsian of Réideschbaach near Heiderscheid in Luxembourg based on a fragmented carapace with typical ornament.

2 Material and methods

The Réideschbaach locality is situated in the Réideschbaach valley, about 2000 m southeast of Heiderscheid and geologically it is part of the Givonne-Oesling-Anticline (Basse et al. 2006; Basse & Franke 2006). A preliminary faunal list was given by Basse & Franke (2006), who described a unique trilobite association for the ardenno-rhenish realm from this locality. Furthermore, these authors confined the age of the main fossiliferous layer near the Siegenian/Emsian boundary, most probably to the early lower Emsian in terms of the Rhenish stratigraphic frame.

The specimen is a strongly fragmented carapace preserved as a more or less 3-dimensional cavity within an iron-rich concretion. Parts of the integument were freed from a powdery, concealing substance or from sediment using pneumatic chisels and coated with MgO prior to photographing. Photographs were taken with a Canon EOS 600D SLR camera equipped with a Canon EF-S 60 mm macro lens and were processed and arranged into figures using Adobe Photoshop CS2. Depth of field was increased by combining a number of photographs with varying planes of sharpness using image stacking software CombineZP (by Alan Hadley).

Institutional abbreviations: NHMMZ, State Collection of Natural History of Rhineland- Palatinate at the Natural History Museum, Mainz. SMF Mbg., Marburg collection, now at Senckenberg Forschungsinstitut, Frankfurt a. M.

The Réideschbaach fossil is stored in the collection of the National Museum of Natural History at Luxembourg and can be accessed under the repository number EIA801.

3 Systematic Palaeontology

Phylum ARTHROPODA Gravenhorst, 1843
Subphylum CRUSTACEA Brünnich, 1772
Class MALACOSTRACA Latreille, 1802
Subclass PHYLLOCARIDA Packard, 1879
Order ARCHAEOSTRACA Claus, 1888
Suborder RHINOCARIDINA Clarke in Zittel, 1900
Family RHINOCARIDIDAE Hall and Clarke, 1888

Genus *Nahecaris* Jaekel, 1921

Type species: *Nahecaris stuertzi* Jaekel, 1921

Diagnosis: see Poschmann 2021

? *Nahecaris* sp.

Description

The specimen is preserved in a concretion of reddish-stained, iron-rich siltstone rich in mica. The concretion was broken and recovered parts were reglued using cyanacrylat. The concretion is about 100 mm long and 65 mm wide with a thickness of about 44 mm. The enclosed fossil was apparently broken prior to embedding as fragments with differing ornament were found isolated within the matrix. Large parts of the cuticle obviously belong to the carapace (Pl. 1.3.-1.5.), but some fragments may originate from abdominal segments (Pl. 1.2.) based on an ornament reminiscent of that on pleomeres of the ceratiocaridid *Ceratiocaris* or of the rhinocaridid *Dithyrocaris* for example~~s~~ (cf., Rolfe 1962; Racheboeuf 1998). Generally, the ornament is distinct and consists of thin, more or less continuous ridges (Pl. 1.4.) that may show short, oblique ridges in between (Pl. 1.3.). The ornament on other fragments is more irregular or scale-like with ridges approaching a triangular, somewhat pointed shape (Pl. 1.2.). Very strong, short and oblique ridges decorate the supposed ventral carapace margin or doublure (Pl. 1.5.).

Discussion

Archaeostracan phyllocarids often show a distinctive carapace ornamentation (e.g., Broili 1929; Rolfe 1962, 1969; Sturgeon et al. 1964; Stumm & Chilman 1969; Bergström et al. 1987; Racheboeuf & Rolfe 1990; Vannier et al. 1997; Racheboeuf 1994a, 1998; Racheboeuf et al. 2000; Brauckmann et al. 2002; Rode & Lieberman 2002; Crasquin et al. 2009; Racheboeuf & Clement 2009; Collette & Hagadorn 2010; Collette & Rudnick 2010; Briggs et al. 2011; Racheboeuf & Gourvennec 2013; Bergmann & Rust 2014; Collette & Plotnick 2020; Poschmann 2021; Liu et al. 2023), which is a hitherto under-explored tool in the identification of taxa. Despite its often poor preservation, it seems highly rewardable to focus more closely on this feature in future studies.

The carapace of the Réideschbaach specimen shows a robust ornamentation (Pl. 1) most closely matching the ornament of rhinocaridid archaeostracans (see also Racheboeuf 1994b). It vaguely corresponds to that described in various species of the genus *Nahecaris* (e.g., Bergström et al. 1987; Brauckmann et al. 2002; Klug et al. 2008; Poschmann 2021) (Pl. 2). Unfortunately, specimens with well-preserved carapace outlines and equally well-preserved ornamentation are rare and the latter is affected by preservation, i.e. compaction and tectonic distortion (Bergström et al. 1987). Furthermore, the ornament varies with the position on the carapace and potentially also with sex and ontogeny. However, based on similarities of the ornament, we assign the Réideschbaach specimen to Rhinocarididae, but a definitive proof for the presence of a posterior (and anterior) median plate is lacking. The overall similarity of the ornamentation of the Réideschbaach specimen with various species of *Nahecaris* furthermore suggests that we are in fact dealing with a species tentatively attributable to *Nahecaris*. The lack of an exact match in ornamental features suggests the possible presence of a hitherto undescribed species. Only further and more completely preserved material may resolve these taxonomic uncertainties.

There are several possible explanations for the function of the carapace ornament. According to Collette & Plotnick (2020) it may have stiffened the exoskeleton and thus provided mechanical resistance to crushing by predators, or ridges may have functioned as a hydrodynamically stabilizing means while swimming. Especially an ornament of strong ridges or 'terrace lines' has been interpreted as an adaptation to a benthic lifestyle associated with burrowing behaviour by increasing friction (Seilacher 1973; Vannier et al. 1997; Bergmann & Rust 2014) whereas a pelagic lifestyle seems to be more often associated with thinner carapaces showing only weak or no ornamentation at all, although micro-ornaments may have served in breaking up a turbulent boundary layer around the swimming animal (Vannier et al. 1997, 2003). Large size and relatively thick integument with robust ornamentation suggest a nectobenthic and/or occasionally infaunal lifestyle for the Réideschbaach specimen, as it has been assumed for *Nahecaris stuertzi* Jaekel, 1921 (Bergström et al. 1987; Rust et al. 2016) from the Rhenish Lower Devonian. The preservation of associated cuticle scraps showing different ornament suggests fragmentation prior to burial and hints at the presence of a possible prey remain.

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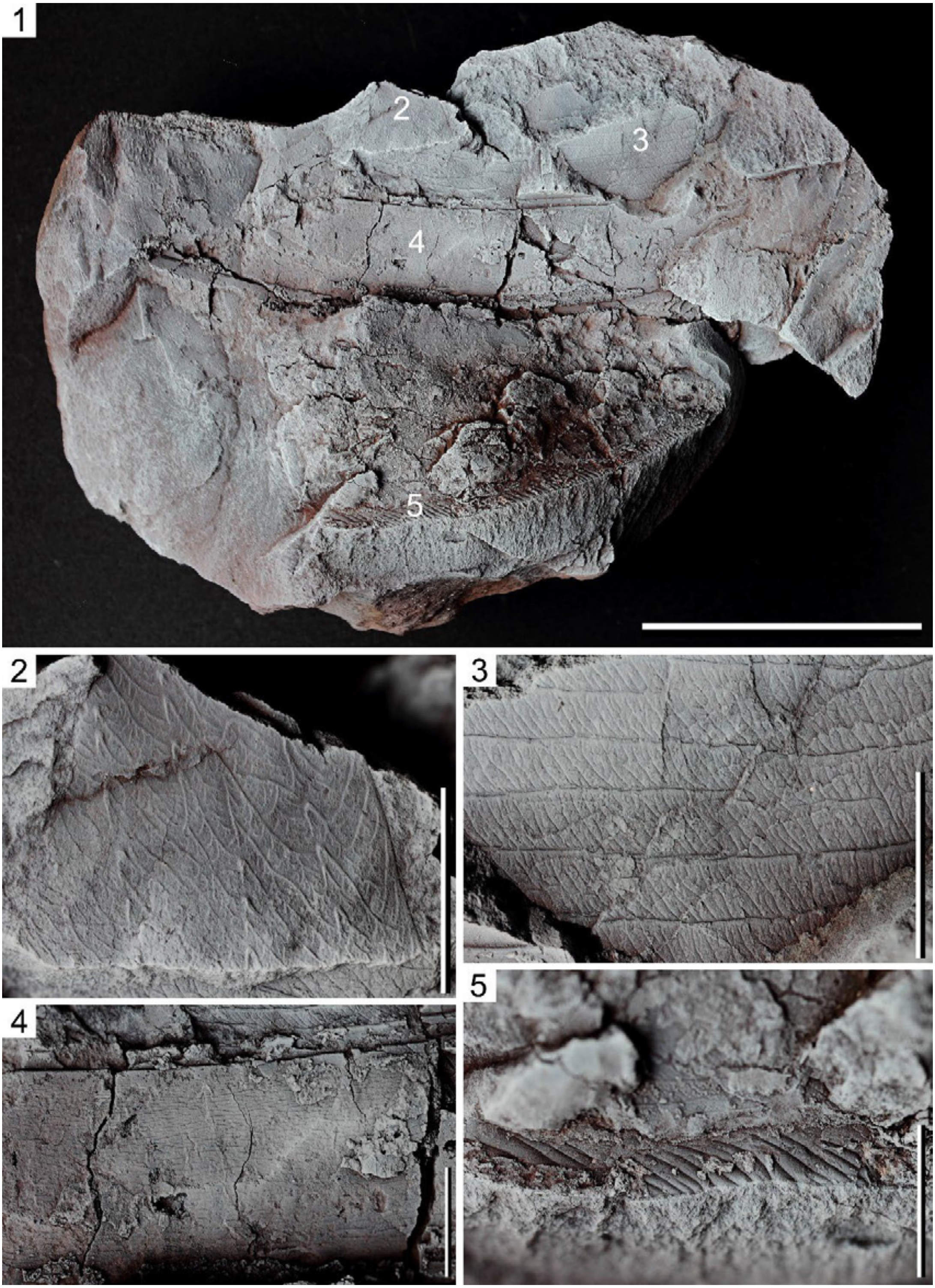
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Plate 1

Phyllocarid (? *Nahecaris* sp.) from the lower Emsian Réideschbaach site, Luxembourg (EIA801).

1. More complete half of the reddish concretion. Whitened with MgO. M = 30 mm. White numbers refer to the position of details shown in 2-5.

2. Cuticle with triangular scale-like ornament. Scale = 5 mm.

3. Cuticle with more or less continuous ridges with short oblique ridges in between. Scale = 5 mm.

4. Cuticle with fine, long ridges. Scale = 5 mm.

5. Strong short and oblique ridges at the supposed ventral carapace margin. Scale = 5 mm.

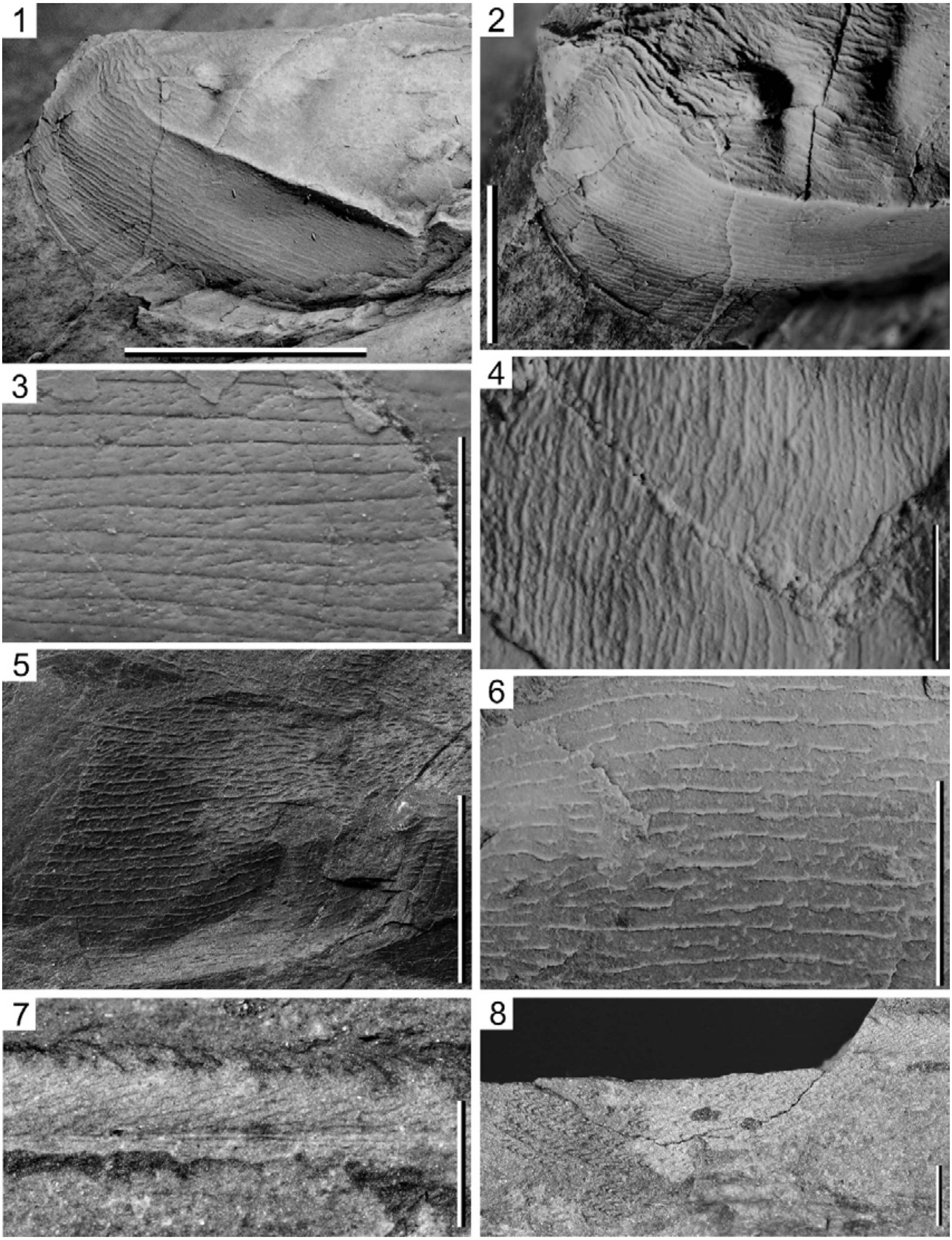
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Plate 2

Cuticle ornament of ***Nahecaris* species** from the Rhenish Lower Devonian.

1.-2. ***Nahecaris sabineae*** Poschmann, 2021 from the upper Emsian Rupbach Slate of Heckelmann Mill near Steinsberg, Rhineland-Palatinate, Germany (whitened silicone cast of holotype NHMMZ PWL 2020/6512-LS) (from Poschmann 2021). **1.** Anterior carapace ornament of more or less continuous ridges ventral of lateral carina. Scale = 10 mm. **2.** Anterior carapace ornament of discontinuous ridges dorsal of lateral carina. Scale = 5 mm.

3.-4. ***Nahecaris lata*** (Traquair in Walther, 1903) from the upper Emsian Kieselgallen-Schiefer at Roßbach near Gladenbach/Hesse, Germany; holotype, SMF Mbg. 3079 (from Poschmann 2021). **3.** Ornament of continuous ridges with short oblique ridges in between, from carapace area between lateral carina and ventral rim. Scale = 2 mm, **4.** Ornament of slightly undulating and somewhat knobby ridges from dorsal carapace area. Scale = 2 mm.

5.-6. ***Nahecaris* sp.** from the lower Emsian of Kreuzberg Mine at Weisel Germany (NHMMZ PWL 2020/6511-LS). **5.** Ornament of continuous and discontinuous ridges dorsal of lateral carina. Scale = 10 mm., **6.** Carapace ornament of mostly discontinuous ridges with small triangular scale-like elements in between. Scale = 5 mm.

7.-8. ***Nahecaris* cf. *frankei*** (Brauckmann, Koch & Gröning, 2002) from the lower Emsian Nellenköpfchen Formation at Urbar near Koblenz, Germany (NHMMZ PWL 2020/6515-LS) (from Poschmann 2021). **7.** Ornament of dorsal median plate, showing short oblique ridges and thorn-like dorsal elements. Scale = 1 mm, **8.** Ornament of dorsal posterior carapace region, showing oblique rows of small scale-like elements. Scale = 1 mm.

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Scyphozoa

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Schlüsselwörter: *Conularia*, Unterdevon, Réideschbaach, Emsium, Luxemburg.

Zusammenfassung

Der vorliegende Neufund von *Conularia eifliensis* Steininger, 1853 ist das bisher besterhaltene Exemplar dieser Art. Bemerkenswert ist die große stratigraphische Verbreitung dieser Spezies.

Keywords: *Conularia*, Lower Devonian, Réideschbaach, Emsium, Luxembourg.

Abstract

The present new find of *Conularia eifliensis* Steininger, 1853 is the best preserved specimen of this species so far. Remarkable is the wide stratigraphic distribution of this species.

Mots clés : *Conularia*, Dévonien inférieur, Réideschbaach, Emsium, Luxembourg.

Résumé

Cette nouvelle découverte de *Conularia eifliensis* Steininger, 1853 est le spécimen le mieux conservé de cette espèce à ce jour. La grande répartition stratigraphique de cette espèce est remarquable.

1. Abkürzungen und Definitionen

MnhnL - Sammlung des Musée national d´histoire naturelle Luxembourg.

Réideschbaach-Schichten – diese Bezeichnung wird hier als informeller Begriff für die Siltsteine mit Konkretionen und quarzitischen Sandsteine vom Réideschbaach benutzt. Sie entsprechen dem unteren Teil der Oberen Tonschiefer-Abfolge bei Lunkenheimer (Basse & Franke 2006: 9, Tab. 1).

REI 1 – Fundpunkt in und um den Réideschbaach bei Heiderscheid mit folgenden GPS- Daten:
49°52'49.42''N, 6°00'27.05'' O.

2. *Conularia* Sowerby, 1821

Conularia eifliensis Steininger, 1853

Material: ein Steinkern mit zwei Seiten eines doppelseitig zusammengedrückten Skelett-Anteils, aufbewahrt im MnhnL unter Nr. EIA 670, Taf. 1: 1a-c.

Morphologie: Mit seinen Maßen reiht es sich sehr genau in die Variationsbreite dieser Spezies ein (vgl. Franke 2010: 23-27): Spitzwinkel je Gehäuseseite 20°; 30 Querrippen auf 5 mm Länge; je ca. 40 Knötchen auf 5 mm Länge einer Querrippe als Gehäuseskulptur.

Bemerkungen: Mit dem Vorkommen in den Réideschbaach- und Wiltz-Schichten kann die Lebenszeit von *C. eifliensis* vom unteren Unter-Emsium bis zum mittleren Ober-Emsium als gesichert betrachtet werden. Verbreitung: Oesling, Luxemburg und West-Eifel, Deutschland.

Conularien sind ganz allgemein seltene Gäste der unter-devonischen Fauna. Neben den mittlerweile reichlich aufgefundenen Exemplaren aus der klassischen Hunsrückschiefer-Fazies sind im übrigen Ablagerungsraum die Stücke gezählt. In den verschiedenen Museen und Sammlungen befinden sich zudem häufig schlecht erhaltene Exemplare, meist ohne genaue Fundortangabe. So listet Hergarten (1985) mit Ausnahme von vier unter-devonischen Arten des Hunsrück-Schiefers lediglich sieben unter-devonische Conularien im ardenno-rheinischen Raum auf.

3. Literatur

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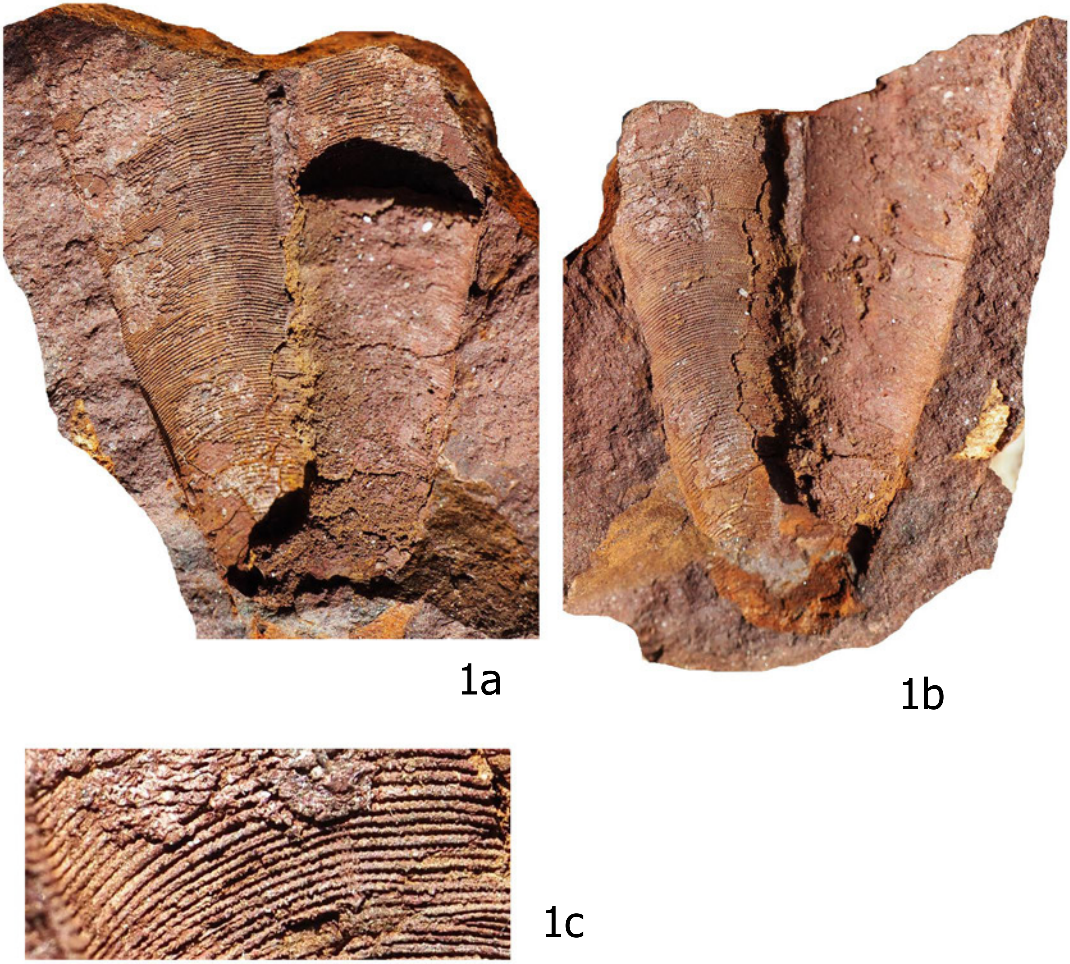

Tafel 1

Conularia eifliensis Steininger, 1853; unvollständiger Steinkern; MnhnL EIA 670. - Réideschbaach-Schichten, unteres Unter-Emsium. Fundort Réideschbaach (Rei 1) bei Heiderscheid, Oesling, Luxemburg. **1a.** Ansicht einer Gehäuseseite und eines zweiten Gehäuseseiten- Fragmentes mit deren Verlängerung als Gehäuseabdruck, x 2, **1b.** Ansicht der Gegenseite, **1c.** Gehäuseausschnitt zum Verdeutlichen der Gehäuseskulptur, x 2,6.

Taxonomy and palaeogeographic affinities of early Emsian (Lower Devonian) trilobites from near Heiderscheid (Éislek, Luxembourg)

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Schlüsselwörter: Trilobita, Devon, Luxemburg, Belgien, Spanien.

Zusammenfassung

Eine gemischte rheinisch-herzynische Trilobitenfauna wird dokumentiert aus Schichten des unteren Emsiums (Unterdevon) von der Fundstelle Réideschbaach bei Heiderscheid, Luxemburg, Ardenno-Rheinisches Gebirge. Frühere Studien haben zur Identifizierung von 12 verschiedenen Arten von Trilobiten geführt; unser Material enthält mehrere davon. Neu beschriebene Taxa sind *Arduennella janseni* n. sp. und *Timsaloproetus xenos* n. sp. von Réideschbaach, und *Alatacastava corbachoi fantasma* n. gen. et n. ssp. (Acastavinae) aus dem unteren Emsium von Spanien. Zusätzlich dokumentieren wir ein komplettes *Rhenops*-Exemplar, das einen seltenen Fall von epizoischem Wachstum aufweist. Die Trilobiten bestätigen einmal mehr das ursprünglich vorgeschlagene frühe Emsium-Alter der Réideschbaach-Fauna und Beziehungen zu Perigondwana und Gondwana. Eine kürzlich dokumentierte gemischte rheinisch-herzynische Trilobitenfauna aus dem Pragium im Longlier–Martelange-Gebiet im nahen Belgien hat ebenfalls Elemente ergeben, die auf einen temporären Austausch mit Gondwana-Terranen hindeuten, aber keine einzige Gattung wird mit der untersuchten Fauna aus Luxemburg geteilt. Die zeitlichen und lokalen Vorkommen exotischer Elemente in Réideschbaach und im Raum Longlier–Martelange werden als Einwanderungs-Epibole bezeichnet.

Keywords: Trilobita, Devonian, Luxembourg, Belgium, Spain.

Abstract

A mixed Rhenish-Hercynian trilobite fauna is recorded from lower Emsian (Lower Devonian) strata in the Réideschbaach locality near Heiderscheid, Luxembourg, Ardenno-Rhenish Mountains. Previous investigations have led to the identifications of 12 distinct species of trilobites; our material is inclusive of several of these. Newly described taxa are *Arduennella janseni* n. sp. and *Timsaloproetus xenos* n. sp. from Réideschbaach, and *Alatacastava corbachoi fantasma* n. gen. et n. ssp. (Acastavinae) from the lower Emsian of Spain. Additionally, we record a complete specimen of *Rhenops* exhibiting a rare case of epizoic growth. The trilobites corroborate once more the previously assumed early Emsian age of the Réideschbaach fauna and affinities with (peri-)Gondwana. A recently documented mixed Rhenish-Hercynian trilobite fauna from the Pragian in the Longlier–Martelange area across the Belgian border has also yielded elements indicative of temporary exchange with Gondwanan terranes, but not a single genus is shared with the investigated fauna from Luxembourg. The temporal and local occurrences of exotic elements in Réideschbaach and the Longlier–Martelange area are referred to as incursion epiboles.

Mots clés: Trilobita, Dévonien, Luxembourg, Belgique, Espagne.

Résumé

Une faune de trilobites mixte, rhénane et hercynienne, est documentée dans les strates de l'Emsien inférieur (Dévonien inférieur) dans la localité de Réideschbaach près de Heiderscheid, Luxembourg, Montagnes ardenno-rhénanes. Des études antérieures ont conduit à l'identification de 12 espèces distinctes de trilobites; notre matériel comprend plusieures d'entre elles. Les taxons nouvellement décrits sont *Arduennella janseni* n. sp. et *Timsaloproetus xenos* n. sp. de Réideschbaach, et *Alatacastava corbachoi fantasma* n. gen. et n. ssp. (Acastavinae) de l'Emsien inférieur d'Espagne. De plus, nous enregistrons un spécimen complet de *Rhenops* présentant un cas rare d'encrassement. Les trilobites corroborent une fois de plus l'âge Emsien inférieur précédemment supposé de la faune de Réideschbaach et les affinités avec le (peri-)Gondwana. Une faune de trilobites mixte, rhénane et hercynienne, récemment décrit dans le Praguien dans la région de Longlier-Martelange, de l'autre côté de la frontière belge, a également fourni des éléments indicatifs d'échanges temporaires avec les terranes gondwaniens, mais pas un seul genre n'est partagé avec la faune étudiée du Luxembourg. Les occurrences temporelles et locales d'éléments exotiques à Réideschbaach et dans la région de Longlier–Martelange sont interprétées comme des épiboles d'incursion.

1 Introduction

During excavations led by the Musée national d'histoire naturelle, Luxembourg in 2021, fossils encompassing a diverse marine macrofauna including trilobites, were recovered from pelites and red fossiliferous nodules at the Réideschbaach locality (Fig. 1A) in northern Luxembourg (Hellemond & Vellekoop, this volume). Further fieldwork carried out in Réideschbaach by one of us (P.M.) has yielded a substantial amount of trilobite specimens. The investigated levels have been assigned in recent works to informal lower Emsian sequences (Basse & Franke 2006, Basse et al. 2006, Plusquellec & Franke 2010) or to the generally poorly fossiliferous Our Formation (Dejonghe et al. 2017, Dejonghe 2021). The acastid-dominated, mixed Rhenish-Hercynian trilobite fauna that is described here largely originates from ex-situ samples in an alluvial plain. Most of the trilobites were collected from mottled reddish concretions which owe their colour to high amounts of iron-oxides. The stratigraphic position of a putative red fossiliferous layer, or layers, as a primary source of our specimens within the poorly exposed outcrop could not be established (Hellemond & Vellekoop, this volume). Comprehensive accounts of the Réideschbaach trilobite fauna were provided by Basse & Franke (2006) and Basse et al. (2006). We record additional specimens of previously identified and other taxa. Some of these are referred to a new species of *Arduennella*, a genus which was not yet known to occur in Luxembourg. The new material also allows nomenclatural changes to be proposed here, which are chiefly involved with reassignments at the genus level. Notwithstanding difficulties with assigning the Réideschbaach locality to a geological formation or formations, the identified homalonotids afford a fairly conclusive, early to mid-lower Emsian age estimation: *Burmeisterella quadrispinosa* Wenndorf, 1990 is a guide fossil for the Ulmen to Vallendar groups in the Rhenish Mountains, species of *Arduennella* are restricted here to the Ulmen and Singhofen groups, and our *Wenndorfia plana* ssp. material is exceedingly similar to *W. plana plana* (Koch, 1880), which is a marker for the Ulmen and Singhofen groups (Wenndorf 1990, Müller in Basse & Müller 2004, Sandford 2005, van Viersen & Taghon 2020, Alberti & van Viersen 2020; Fig. 1B).

A quick perusal of the trilobites recorded in the current and previous works results in the following updated list of species:

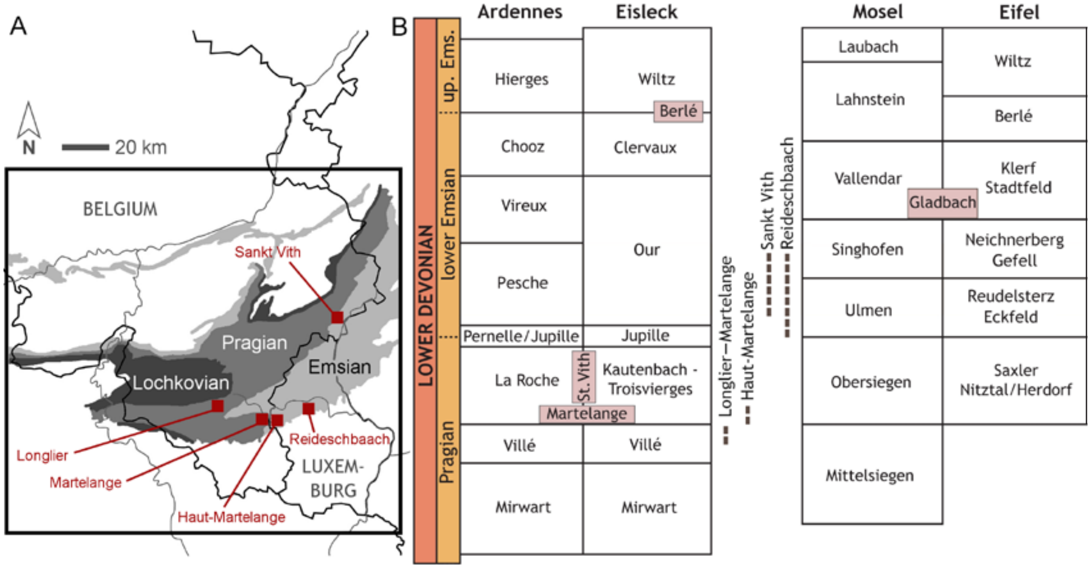


Fig. 1: Lower Devonian outcrops in southern Belgium and northern Luxembourg (A) and standard regional lithostratigraphic units, with approximate ages of Longlier-Martelange, Haut-Martelange, Sankt Vith and Réideschbaach faunas indicated (B). Adopted from van Viersen & Taghon (2020) and modified.

Asteropyginae

Braunops luxemburgensis (Basse, Müller & Franke, 2006) n. comb.

Delocare sp.

Dunopyge oeslingiana (Basse & Franke, 2006) n. comb.

Rhenops australocustos Basse, Müller & Franke, 2006

Treveropyge? sp.

Acastavinae

Alatacastava faberi (Basse & Franke, 2006) n. comb.

Homalonotinae

Arduennella janseni n. sp.

Burmeisterella quadrispinosa Wenndorf, 1990

Spiniscabrella sp.

Wenndorfia plana (Koch, 1880) ssp.

Tropidocoryphinae

Luxembourgcoryphe lunkenheimeri Basse & Franke, 2006

Proetidae, subfamily uncertain

Timsaloproetus xenos n. sp.

Otarioninae

Cyphaspis sp. A ex. gr. *hamidi* Chatterton et al., 2006

Odontopleurinae

Leonaspis? sp.

2 Trilobite biodiversity and palaeogeography

The marine Lower Devonian of the Ardenno-Rhenish Mountains is generally comprised of neritic-siliciclastic sequences (rhenotypic facies of Jansen 2016), sourced primarily from the main Old Red Sandstone Continent to the north and the Mid-German Crystalline High to the south, and deposited in the Rhenohercynian Sea on the southern margin of Laurussia (e.g. Ziegler 1990, Meyer & Stets 1996; Hellemond & Vellekoop, this volume, Fig. 2D, E). The northward transgressive character of the shallow shelf sea is marked by diachronous base conglomerates and arenaceous sediments which were laid down unconformably on a denuded Caledonian basement (e.g. Steemans 1989, Godefroid & Cravatte 1999, Sintubin et al.

2009, Meyer 2013). Noteworthy palaeogeographic changes of the Rhenohercynian Sea occurred in mid-Early Devonian times. The reconstructions by Grigowski & McCann (2021) indicate a deepening trend under relatively uniform subsidence during the Pragian, followed by increased subsidence in the central basin and a relatively lower sea level in the lower Emsian. This led to varied facies developments across the basin.

2.1 Faunal turnover in the Lower Devonian

Devonian trilobites are deemed to have been obligate benthic inhabitants of epicontinental seas, depending on suitable shallow-water migration routes and with biofacies controlling the diversity and evolution of communities in space and time (Feist et al. 2007). At the outset, the trilobite fauna of the shallow-marine eurhenotypic subfacies in the Ardenno-Rhenish Mountains was typified as poorly diversified and dominated by Rhenish acastids and homalonotids, and this has long remained the generally accepted view (e.g. Erben 1962, 1964, Erben & Zagora 1967, Basse 2003, Crônier & van Viersen 2007, Feist et al. 2007, Jansen 2016). Large-scale establishment of Hercynian trilobites along with a shift in the depositional regime in the basal upper Emsian Wiltz Formation in the Éislek and Eifel, precursory to the rich and widespread Middle Devonian associations of the allorhenotypic subfacies, was documented mainly by Basse (2003), Basse & Müller (2004), Franke (2010) and Müller & Franke (2012). The rich, mixed Rhenish-Hercynian trilobite fauna of the upper Emsian Rupbach Shales in the Lahn Syncline was treated in detail by Basse & Müller (2016). In the Ardennes, the putative first regional appearances of Hercynian trilobites may be inferred from the pioneering works of Eugène Maillieux (e.g. Maillieux 1933), who listed species names in Phacopinae, Odontopleurinae and Proetinae as occurring in the basal upper Emsian Hierges Formation, a lateral facies variant of the Wiltz Formation cropping out along the southern limb of the Dinant Synclinorium. Maillieux' original specimens were only recently figured, and their taxonomic assignments confirmed at the subfamily level (van Viersen 2013), but data on Emsian trilobites from the Ardennes remain generally scanty. All these examples are more or less consistent with the notion of decreased trilobite provincialism effected by the early upper Emsian transgressive Daleje Event (Chlupáč & Kukal 1986, Chlupáč et al. 2000), although Jansen (2016) pointed out the approximate nature of some of the correlations. Disappearances and small-scale extinctions near the Lower–Middle Devonian boundary (e.g. *Basidechenella*, *Wenndorfia*) followed by new incursions in the lower Eifelian, underline the importance of geographic modes of speciation to the evolution of Devonian trilobite faunas in the Rhenohercynian Sea (van Viersen et al. 2019).

2.2 Early Devonian incursion epiboles

The paucity of Hercynian trilobites in the Lochkovian–early Emsian fossil record of the Ardenno-Rhenish Mountains can no doubt in part be attributed to prolonged intervals of unfavourable depositional environments (e.g. Lecompte 1962) and a deficient prospection of Lower Devonian outcrops for their trilobite contents compared, e.g., to the Middle Devonian (Basse et al. 2006, van Viersen & Prescher 2009, van Viersen 2013). But the rather temporal and local character of the rich (both in diversity and numbers of individuals) Réideschbaach fauna within the mostly poorly fossiliferous lower Emsian sequences in the region, demands that alternative causes be factored in. Basse & Franke (2006) and Basse et al. (2006) recognised the unique composition of the mixed Rhenish-Hercynian Réideschbaach trilobite fauna, which demonstrates only partial overlap with the latest Pragian to late lower Emsian "Rhenish standard fauna" (*sensu* Basse et al. 2006). Shortly after, van Viersen & Prescher (2009) revisited and figured the slightly older, mixed Rhenish-Hercynian trilobite associations mentioned previously by Asselberghs (1913) and Maillieux (1914, 1936) as occurring in the Quartzophyllades de Longlier (Longlier Formation of Vandenven 1990; Longlier facies of the Villé Formation *sensu* Dejonghe 2013) in SE Belgium (Figs 1, 2). The trilobite specimens come from several localities in the Longlier–Martelange area, at less than 20 km west of Réideschbaach. In contrast with the ephemeral Réideschbaach fauna, van Viersen & Prescher (2009) noticed the comparatively large stratigraphic and geographic extents of the Belgian trilobite associations. Yet even collectively, the

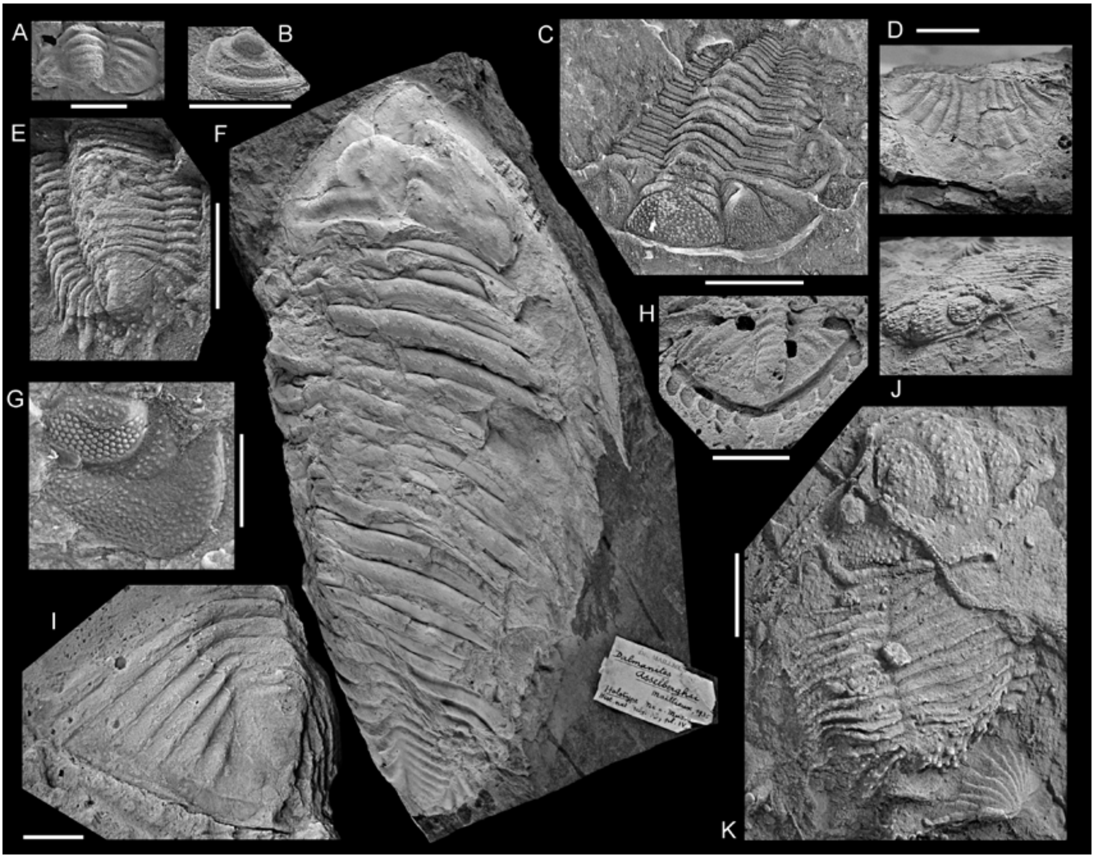


Fig. 2: Selected trilobites of the Longlier–Martelange fauna from the Villé Formation, Pragian; Belgium. **A:** Phacopinae gen. & sp. indet., internal mould of a pygidium; IRSNB a12679. - Martelange. **B:** *Gerastos*? sp.; external mould of a librigena; IRSNB a12687. - Martelange. **C:** *Pseudocryphaeus*? sp.; external mould of a tectonically deformed, incomplete specimen; IRSNB a12685. - Longlier. **D:** *Paralejurus* sp.; internal mould of a pygidium; IRSNB a12683. - Martelange. **E:** *Huginarges* sp.; resin cast of a thoracopygidium; IRSNB a12676. - Longlier. **F:** *Scabrellana asselberghsi* (Maillieux, 1936); internal mould of holotype incomplete specimen; coll. Katholieke Universiteit Leuven, unnumbered. - Martelange. **G:** Phacopinae gen. & sp. indet., external mould of a fragmentary cephalon (digitally inverted image); IRSNB a12680. - Martelange. **H:** *Pseudocryphaeus*? sp.; internal mould of a pygidium; IRSNB a12686. - Longlier. **I:** *Parahomalonotus* sp.; internal mould of a tectonically deformed pygidium; IRSNB 12688. - Longlier. **J, K:** *Huginarges* sp.; resin cast of an incomplete specimen; IRSNB a12677. - Longlier. Scale bars indicate 10 mm. Holotype of *S. asselberghsi* is 340 mm long.

composition of the Longlier–Martelange fauna is very distinctive from the Réideschbaach fauna in the occurrences of *Paralejurus* (see Basse & Müller 2016 for remarks), *Huginarges* (see van Viersen 2021b for remarks), *Scabrellana* Harzhauser & Landau, 2021, *Gerastos*? (see van Viersen 2021a for remarks), *Pseudocryphaeus*?, a scutelluine and a phacopine, whereas *Parahomalonotus* and perhaps also *Scabrellana* primarily underline its Pragian age. In fact, not a single genus is shared between the two faunas.

In the absence of meaningful correlations between the Hercynian elements from Réideschbaach and the Longlier–Martelange area and other parts of the Ardenno-Rhenish Mountains, questions rise as to their origins. The Réideschbaach and LM (Longlier–Martelange) trilobite faunas, each of unique composition and temporal character within the eurhenotypic subfacies, are currently best interpreted as incursion epiboles (*sensu* Brett & Baird 1997) linked to individual bioevents. It follows that the exotic taxa invaded into the

Rhenohercynian Sea from elsewhere and that they were unviable to persist here for longer periods of time. The palaeogeographic affinities of the Réideschbaach trilobite fauna were discussed by Basse et al. (2006) and will be elaborated on below.

The provenance of the LM trilobite fauna is considered forthwith. The Villé Formation in which it occurs was classified by Godefroid et al. (1994) as indeterminate Pragian due to the lack of useful guide fossils. Resemblances of its macrofauna to that of the middle Siegenian (~middle Pragian) part of the Wied Group in the Westerwald have been pointed out elsewhere (Dahmer 1932, Jansen 2016). Brachiopods may permit correlation of the middle–upper Siegenian boundary with the transition between the Villé Formation and the overlying La Roche Formation (Jansen 2016). The trilobite occurrences are not incongruent with a putatively mid-Pragian age. Wenndorf (1990) and Sandford (2005) showed the upper range of *Parahomalonotus* to extend relatively far into the Pragian but certainly not to reach the Emsian. According to Müller (2005), the oldest *Scabrellana* species occur in the Pragian of southern Morocco and Belgium, although an earliest Emsian age could not be excluded. *Paralejurus* is known from the Pragian in southern Morocco, northwest France and the Barrandian, but it reaches into the lowermost Middle Devonian in places (Schraut & Feist 2004). Both *Paralejurus* and *Scabrellana* are suggestive of exchange of fauna with Gondwana-related terranes although exclusiveness will be hard to substantiate. The only other exotic member of the LM fauna identified at the genus level with certainty, *Huginarges*, was almost cosmopolitan during parts of the Siluro-Devonian, yet known during the Pragian mainly from northern and peri-Gondwana. *Gerastos*, if correctly classified, is of northern and peri-Gondwanan affinity. Van Viersen & Prescher (2009) noticed that the exotic elements in the Villé Formation occurred in proximity of the maximum extent of the Early Devonian transgression in Belgium. Their incursions might be related to the ~mid-Pragian transgressive Gensberg Event of Jansen (2016) but further enquiry will be necessary to validate this.

Basse & Franke (2006) and Basse et al. (2006) pointed out similarities between the Réideschbaach trilobites and early Emsian faunas in northern Spain, southern Morocco, Brittany and the Asian part of Türkiye (all peri- or northern Gondwana). Without reiterating the details of their investigations here, Basse et al. (2006) found resemblances to the fauna of the La Vid Formation in the nearshore Asturo-Leonian Domain of the Cantabrian Mountains to be the most compelling. Our study corroborates this conclusion in part, as it reveals potentially slightly more diffuse palaeogeographic affinities, even though these primarily reside in peri-Gondwana.

Alatacastava: The union of *Alatacastava corbachoi corbachoi* (Basse & Müller, 2016) n. comb. and *Alatacastava corbachoi fantasma* n. gen. et n. ssp. from the offshore Palentine Domain and *Alatacastava smeenki* (Lieberman & Kloc, 1997) n. comb. from the Asturo-Leonian Domain of the Cantabrian Mountains with *Alatacastava faberi* n. comb. from Réideschbaach in a single genus, affirms correlations with trilobite faunas from Spain. Additionally, Morzadec (in Le Menn et al. 1976) recorded cephala that he identified as *Pseudocryphaeus* sp., as components of a richly diversified Rhenish-Hercynian fauna from early lower Emsian transitional beds between the Faou and Reun ar C'Hrank formations in the Massif armoricain. The French cephala are clearly acastavine and almost certainly represent an undescribed *Alatacastava* species, thus expanding the known early Emsian distribution of this genus within peri-Gondwana.

Braunops and *Dunopyge*: Morzadec (in Le Menn et al. 1976) described *Pilletina aulnensis* in the Massif armoricain, and Smeenk (1983) figured potentially conspecific specimens from the lower Emsian of the Cantabrian Mountains. The prevailing generic concept of *Pilletina* is problematic even for the principal fact that its type species, *Asteropyge* (*Metacanthina*) *oehlerti praecursor* Pillet, 1958, is only known with certainty from the largely exfoliated holotype extracted from an undefined Pragian to upper Emsian level in the Massif armoricain. Comparisons with other species, often established on the basis of isolated sclerites of varying preservation, are conjectural. Bignon & Crônier (2013) excluded *P. luxemburgensis*, *P. oeslingiana* (both Réideschbaach) and *P. aulnensis* from *Pilletina*, stating that their generic affinities are uncertain. *Pilletina oeslingiana* is herewith transferred to *Dunopyge*. Similarities between the other two species are taken note of but their taxonomic revision is beyond the scope of this work. *Pilletina luxemburgensis* is only known with certainty from pygidia. We propose to provisionally reassign this species to *Braunops* (see below).

Timsaloproetus: Early Emsian species of *Timsaloproetus* occur in Türkiye and possibly also in Spain, subsequent to a necessary revision of *Paralepidoproetus* (see below).

Cyphaspis and *Leonaspis*: The origins of the *Cyphaspis* and *Leonaspis* species are not very categorical seeing as these genera demonstrate nearly cosmopolitan distributions. Our *Cyphaspis* sp. A is a "primitive" member of the *Cyphaspis hamidi* group of van Viersen & Holland (2016), known in the late lower Emsian exclusively from the Cantabrian Mountains and the Massif armoricain. According to Ramsköld & Chatterton (1991), *Leonaspis* was exclusively Gondwanan but Basse & Müller (2016), in repeating Burhenne's (1899) illustration of a typical *Leonaspis* specimen from the Leun-Schiefer in the Lahn Syncline, showed this information to be incorrect. Other records from the autochthonous parts of the Ardenno-Rhenish Mountains demonstrate that the genus was well established in Avalonia during the Emsian (e.g. Basse & Müller 2004, 2016, Franke 2010, van Viersen 2013, Alberti 2018a, Flick & Flick 2021).

Luxembourgcoryphe: The monotypic *Luxembourgcoryphe* is only known from Réideschbaach and its potential provenances can only be guessed, although a close affinity with *Astycoryphe* of wide palaeogeographic distribution, would not be unthinkable.

The acastid-homalonotid component of the Réideschbaach fauna reveals many resemblances to early Emsian faunas of the eurhenotypic subfacies of the Ardenno-Rhenish Mountains (e.g. the Gladbach- and Stadtfeld-Schichten in the Eifel (Basse 2003) and the Our Formation in eastern Belgium (van Viersen & Taghon 2020)) although the identified genera are also known from Spain or Morocco, with *Burmeisterella* as the only exception. Species of this last genus are known outside the Ardenno-Rhenish Mountains from the Lochkovian or Pragian of Brazil (southwestern Gondwana) and the Pragian or Emsian of Portugal (peri-Gondwana) (De Carvalho 2005, Caprichoso 2019). Those records may predate the oldest occurrences of congeners in the Ardenno-Rhenish Mountains, which are Pragian, and could bespeak a Gondwanan origin of *Burmeisterella*. De Carvalho (2005) and Sandford (2005) listed differences between *Burmeisterella* and the morphologically similar *Burmeisteria*, which is restricted to the Ludlow to Middle Devonian of southwestern Gondwana, but their phylogenetic relationship remains to be investigated.

2.3 Latest Pragian to early Emsian bioevents

Accepting that the exotic elements in Réideschbaach are best construed as incursion epiboles, a review of potential bioevents that contributed to their migrations is pertinent here. The most obvious candidate may be the transgressive, lower Emsian, Basal Zlíchov Event (BZE). This event was briefly introduced by Chlupáč & Kukal (1986) who emphasised its local importance within the Barrandian. Later, Chlupáč (1994), Chlupáč & Lukeš (1998) and Chlupáč & Kolař (2001) credited the BZE with biotic effects of far greater significance. Chlupáč (1994) noted innovations (especially in asteropygines) and decreased provincialism of early Emsian trilobites, leading to commonly mixed associations of Rhenish and Hercynian taxa in the Rhenish-Bohemian Province (*cf*. Dowding & Ebach 2019). Chlupáč & Kolař (2001) described the marked, early Emsian influx in the Barrandian of various exotic macrofaunal elements, including trilobites, from the Rhenish Massif and distant areas (Australia, North America, Kazakhstan, Spain, NW Africa). One of these, *Parahomalonotus novaki* Chlupáč & Kolař, 2001, was reclassified by van Viersen & Prescher (2009) as a species of the palaeogeographically widely distributed *Wenndorfia*. Chlupáč & Kolař (2001) highlighted the significance of the BZE seeing as migration and exchange of faunas between Gondwana and Laurussia were open at this time and not hindered by a vast ocean. Botquelen et al. (2001) identified the BZE in the upper part of the Faou Formation in the Massif armoricain, i.e., in the interval that yielded the mixed Rhenish-Hercynian fauna including *Alatacastava*, described by Le Menn et al. (1976). García-Alcalde (1997) correlated the BZE with a distinctive lithological transition in Spain along with the first occurrences of very abundant and diverse trilobite faunas of mixed Rhenish-Hercynian type, while pointing out striking similarities to trilobite faunas from the Palentine Domain and the Massif armoricain. While these observations may afford the Réideschbaach fauna a satisfactory position within a conceptual early Emsian palaeobiogeographic framework, the timing of some of the trilobite occurrences and putative migrations is not always coherent. For instance, García-Alcalde's BZE is different from the slightly younger BZE originally described by Chlupáč & Kukal (1986) in the Barrandian (see remarks by Aboussalam et al. 2015) and may correspond to the latest Pragian to earliest Emsian Saxler Event instead (Mittmeyer 2008, Jansen 2016). The trilobites from Spain (e.g. Smeenk 1983) bear many resemblances to Réideschbaach but some of the similarities exist with faunas from the late lower Emsian Requejada Member of the Abadía Formation in the offshore Palentine Domain (e.g. *Cyphaspis* ex. gr. *hamidi*); these could potentially postdate the Luxembourg occurrences.

2.4 Outlook

The known onsets of Hercynian trilobites in mid-Pragian to lower Emsian strata in the Ardenno-Rhenish Mountains were plotted by van Viersen & Prescher (2009) along its southern contemporary exposures, in the southeastern Ardennes, the Éislek and the Hunsrück, where conditions for their settlement appear to have been favourable at times. This area, which is probably to include the southern Eifel (Basse et al. 2006), is where incursions are most likely to be discovered as a result of future explorations. It is worth mentioning here that Maillieux (1940) reported, in now obsolete nomenclature, "*Phacops ferdinandi*" in the southeastern Ardennes, in the Phyllades de Neufchâteau of the Grauwacke de Grupont, which he correlated with the lower part of the Hunsrück-Schiefer. A single, undeterminable phacopine specimen with matching data according to its label was traced by one of us (A.V.) in the Maillieux collections of the Institut royal des Sciences naturelles de Belgique. The trilobite is preserved in a roofing slate and was collected from the former Rothers ardoisière (underground mine) in Haut-Martelange, Luxembourg (Fig. 1A). The specimen likely comes from the upper Pragian Martelange Member of the Kautenbach-Troisvierges Formation of Dejonghe et al. (2017) (Fig. 1B).

In all, it has to be assumed that the regional influx of exotic elements during the Lower Devonian was not the result of a single bioevent, even if merely considering the LM and Réideschbaach examples here. However, reconstructing the sequence and effects of events is difficult. Previous studies are sometimes convoluted by the applications of regional events at a larger geographic scale on the basis of inconclusive biostratigraphic evidence. Scanty data on vertical distributions of taxa and erratic sampling across environmental gradients are more fundamental problems that are certainly not restricted to the Ardenno-Rhenish Mountains. The account of Chlupáč & Kolař (2001) suggests that the origins of early Emsian Hercynian trilobites may be manifold and that they potentially lie –at least in part– outside the Rhenish-Bohemian Province. This could warrant a reconsideration of the term "Hercynian" or its equivalent "Bohemian", accordingly, when distinguishing between groups of trilobites.

Tab. 1: Tallies of trilobite specimens collected from the Réideschbaach locality during excursions in 2021.

Family	Genus	Rhenish	Exotic?
ACASTIDAE	*Alatacastava*		5
	Braunops		2
	Delocare	1	
	Dunopyge	9	
	Rhenops	10	
HOMALONOTIDAE	*Arduennella*		2
	Burmeisterella	1	
	Spiniscabrella	6	
	Wenndorfia	4	
PROETIDAE	*Timsaloproetus*		11
AULACOPLEURIDAE	*Cyphaspis*		3
ODONTOPLEURIDAE	*Leonaspis*		5
		31	28

Quantifying the allochthonous component of the Réideschbaach trilobite fauna would seem worthwhile to attempt at this point. An approximation is made by comparing our trilobite specimens from Réideschbaach with the Rhenish standard fauna of Basse et al. (2006). We add to that fauna *Spiniscabrella* because the oldest known species occur in the Ardenno-Rhenish Mountains and *Wenndorfia* because it was widespread along the southern margin of Laurussia during the Lower Devonian. Tallies of individuals were aggregated at the genus level and results are presented in Table 1. These show a slight dominance of autochthonous species over potentially invasive ones. However, this projection may be misleading, and we do not advocate its use considering several fundamental problems that require future effort to be resolved: (1) There is, a priori, a sampling bias towards the red nodules which were known to yield the most frequent and exotic trilobite specimens. The geological context of these nodules is very poorly understood. (2) The Rhenish standard fauna as a concept was not defined by Basse et al. (2006) and the generic rank classifications of the Réideschbaach are partly revised in the present paper. (3) Assessing which species are invasive requires thorough knowledge of the stratigraphic ranges of congeners within the Ardenno-Rhenish Mountains and elsewhere, and this is clearly not up to par. That is to say, the ratio of autochthonous/allochthonous taxa is subject to definitions and provisional estimations of their palaeogeographic affinities.

2.5 Ecological epiboles

The occurrence of a member of the oddball homalonotid *Arduennella* in Réideschbaach calls for an appraisal. *Arduennella* was erected as a monotypic genus by Wenndorf (1990), who included in the type species (*A. maillieuxi* (Asselberghs, 1923) from the "phyllades et schistes phylladeux du Hunsrückien supérieur" (revised as Our Formation by van Viersen & Taghon 2020) in Sankt Vith, eastern Belgium (Fig. 1)), specimens from various strata in the Rhenish Mountains ranging from the Ulmen and Singhofen groups. According to van Viersen & Taghon (2020) the type horizon cannot be precisely positioned within the Our Formation due to inaccessibility of the outcrop and the possibility that contact with the underlying Sankt Vith facies (*sensu* Dejonghe et al. 2017) in the area is tectonic, but an early lower Emsian age was tentatively inferred from the trilobites. Alberti & van Viersen (2020) described a new species *Arduennella hainauensis* from the Singhofen Group in the Taunus. Other, as yet formally undescribed species occur in the Pragian of Morocco (Schraut 2000) and the Emsian of Romania (Iordan 1981, Basse & Müller 2016). Kennedy's (1994) record of *Arduennella maillieuxi* from southwest England was accepted by Sandford (2005) but tentatively referred to *Digonus* by Basse & Müller (2016). Based on this information, van Viersen & Taghon (2020) considered *Arduennella* to be of Gondwanan origin and to have radiated palaeogeographically during the late Pragian to early Emsian. This would imply that future discoveries of *Arduennella* can be expected elsewhere in western Europe. The local abundance of *Arduennella* (Alberti 2023) and its patchy distribution, both in space and time, within the Ardenno-Rhenish Mountains may reflect a series of ecological epiboles (*sensu* Brett & Baird 1997), whereby unusual environmental conditions led to brief proliferations. Whether this is also the case in Réideschbaach is difficult to assess based on the available data from ex-situ collections. If so, we would expect future investigations here to reveal relatively abundant occurrences of *Arduennella* in a brief stratigraphic interval, or intervals. Such a claim is currently conjectural.

3 Systematic palaeontology

Material: The trilobite specimens described and figured are deposited in the collections of the Musée national d'histoire naturelle, Luxembourg (EIA), the Museo de Geología, Universidad de Oviedo (DGO), the Senckenberg Museum (SMF), the Institut royal des Sciences naturelles de Belgique (IRSNB), and the Natuurhistorisch Museum Maastricht (NHMM).

Terminology: Morphological terminology used in the descriptions of the trilobite specimens follows that of Whittington & Kelly (1997). Thoracic facetal conditions were coined by Jaanusson (1975). The reader is referred to Fatka & Budil (2021) and van Viersen & Kloc (2022) for the definitions of frontal auxiliary impressions (FAIs): posteromedian impression (pmi) and posterior lateral impressions (pli).

Family ACASTIDAE Delo, 1935

Subfamily ASTEROPYGINAE Delo, 1935

***Rhenops* Richter & Richter, 1943**

Type species: *Cryphaeus anserinus* Richter, 1916, by original designation.

Remarks: A necessary revision of *Rhenops* is hampered by a lack of well-preserved specimens of many of its species. Basse (2003) recognised the *anserinus* and *index* morphogroups within *Rhenops*. His generic concept included *Rhenops babini* Morzadec, 1983 and *Rhenops circumapodemus* Smeenk, 1983, species that were later transferred by Bignon & Crônier (2013) to their new genus *Pennarbedops*. Van Viersen & Kloc (2022) placed *Pennarbedops* in synonymy of *Hollardops* Morzadec, 1997 mainly because of the synapomorphic 10 thorax segments (as against the usual 11 for Asteropyginae) shared by their species. Of interest will be the discoveries of the thoraxes of other species assigned to *Rhenops* by Basse (2003). Bignon & Crônier (2013) excluded several of these from *Rhenops* but without stating why. On the other hand, Bignon & Crônier accepted *Rhenops odremani* De Carvalho & Moody, 2000 from the Middle Devonian of Venezuela as a member of the genus. The Venezuelan material is poorly preserved and although evidently asteropygine, could belong to a range of genera.

***Rhenops australocustos* Basse et al., 2006**

Pl. 1: 1-6, Pl. 2: 1-12

2006 *Delocare*? sp. n. R – Basse: 21.
2006 *Delocare*? sp. n. R – Basse & Franke: 13, 25, Pl. 5 Fig. 9.
* 2006 *Rhenops australocustos* Basse et al.: 251, Pl. 2 Figs 16-20.

New material: A single complete specimen (EIA 750), three cephala (EIA 752, 753, 757), four pygidia (EIA 754-756, 758), a partial cephalothorax (EIA 751) and a putatively conspecific hypostome (EIA 798); from the lower Emsian in Réideschbaach (type locality and horizon).

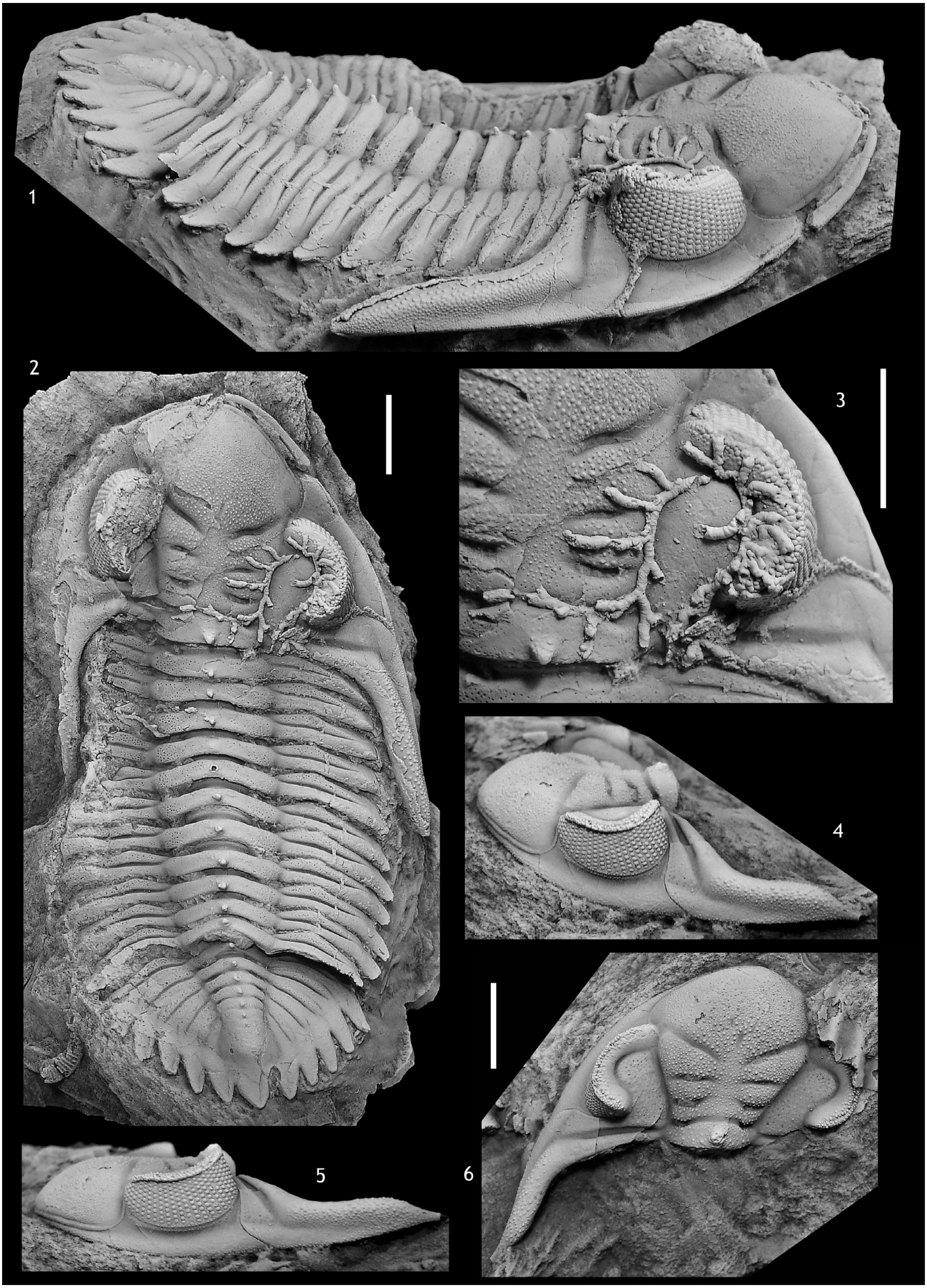
Remarks: *Rhenops australocustos* was established by Basse et al. (2006) on the basis of cephalic and pygidial remains. We record a slightly disarticulated, complete specimen which corroborates the association of the cephalon and pygidium of this species as it was assumed by Basse et al. (2006). The thorax consists of 11 segments. Each ring bears a median node that is likely serially homologous with the nodes on the occipital ring and pygidial axial rings. Close-set pits are concentrated on the anterolateral and lateral parts of the axial rings and the anterior pleural bands. All pleurae demonstrate a postfacetal condition although less clearly so on the posterior segments. The anterior segments are short (tr.) and abaxially continued into short, posterolaterally directed spines. Posterior to these, segments bear consecutively longer and more robust projections.

Our complete *R. australocustos* specimen demonstrates a putative case of commensal fouling, which is exceedingly rare in trilobites. As an example, Key et al. (2010) reported having examined nearly 15.000 *Flexicalymene* specimens, only 0,1% of which showed epizoans or episkeletozoans. Limiting factors for the occurrences and preservation of epizoans were discussed by Brandt (1996) and Key et al. (2010) in the context of calymenids, and these are probably largely homogeneous for trilobites. To our knowledge, epizoic growth on asteropygines has hitherto only been documented by Basse (2006) on the cephalon of *Philonyx*, and by Basse & Müller (2016) and Alberti (2018b) on the cephalon and pygidial spines of *Psychopyge*, all coming from the upper Emsian of the Rhenish Massif. Van Viersen & Kloc (2022) considered *Psychopyge*, with its dorsal and slender long pleural spines, to be a bottom dweller that may have benefited from encrustation in making its exoskeleton stand out less from the environment.

Our complete *R. australocustos* specimen carries a hederelloid colony centrally on the cephalon and right palpebral lobe. There are several reasons to suggest that it attached here in the course of the trilobite's life: (1) Our specimen is almost intact, with the librigenae in place and the facial sutures closed, and with the hypostome in place (unfortunately lost during preparation), from which it may be inferred that it is not an exuvia. Hederelloids were originally classified as bryozoans but Taylor & Wilson (2008) provided arguments to associate the group with phoronids. The colony on the cephalon might have taken several weeks to grow to its currents extent, although this is a rough estimate

Plate 1

Rhenops australocustos Basse, Franke & Müller, 2006. - Lower Emsian; Réideschbaach, Luxembourg. **1-3.** Silicone cast of a nearly complete specimen with hederelloid attached; EIA 750, **4-6.** Silicone cast of a cephalon; EIA 752. Scale bars indicate 5 mm.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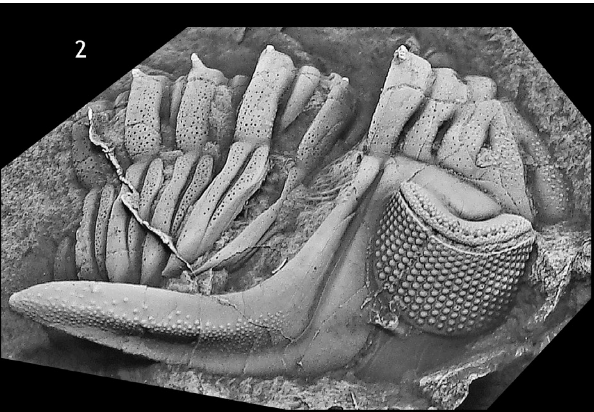

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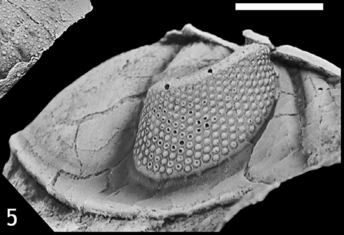

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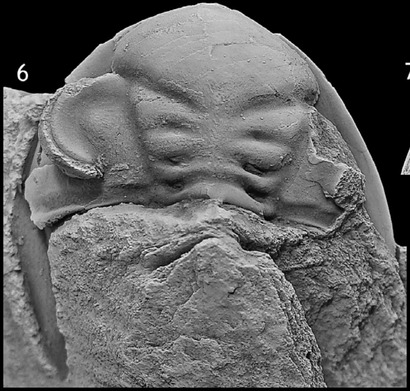

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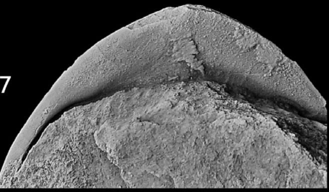

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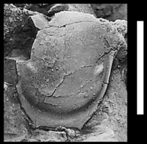

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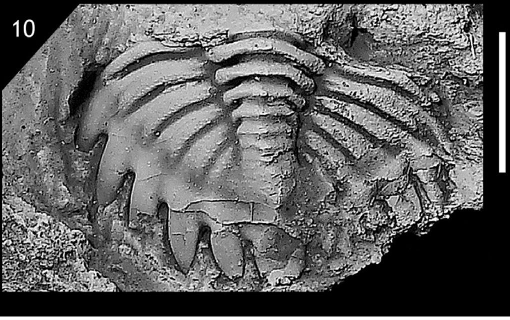

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based on growth rates in bryozoans of overall similarity. Extant marine arthropods employ a range of antifouling behaviours including frequent ecdysis, and this was likely to be commonplace in trilobites as well. Thus, the epizoic growth on the *Rhenops* specimen may have occurred in between moults or the individual had entered terminal anecdysis. (2) It is difficult to dismiss the possibility that the hederelloids attached to the trilobite postmortem but considering the arguments of Hellemond & Vellekoop (this volume) to interpret the Réideschbaach strata as a well oxygenated and hospitable environment to accommodate marine life, it is conservative to assume that scavengers would have disturbed or overturned the carcass in the course of time necessary for the colony to grow to its current extent. (3) Likewise, arthropods are generally prone to postmortal disarticulation as the joints rapidly decay, which would have taken place before the hederelloid colony could grow to its current extent.

The fouling did not result in loss of mobility as in ankylosis of the sclerites. The right visual surface is hardly covered which could not have led to reduced sight of any significance. Smaller (individual?) hederelloid specimens are attached to the thoracic pleurae; the largest of these occurs on the third left pleura and continues onto the abaxial part of the axial ring. Whether their association is haphazard or phoretic, the location of the large hederelloid on the cephalon was favourable seeing as it encompasses a large, stable, dorsally high surface on the trilobite, affording optimal prospect of gathering nutrients. The epizoic presence was not lethal and questionably beneficial other than that it may have afforded its host some sort of camouflage. Van Viersen & Kloc (2022) elaborated on the feeding habits of the morphologically similar *Hollardops*, suggesting that it used its shovel-like cephalon to plough through the top layer of the substrate which was guided and disposed of laterally along the cephalic border and the steep front of the genal spine, and so exposing the appendages to fresh sediment. It is likely that *Rhenops* had the same feeding habits. The epizoic growth was sustainable in that a firm base was established in the deep axial, palpebral, occipital and posterior border furrows, while remaining at a distance from the regions of the exoskeleton that would have been involved in ploughing activities.

Delocare Struve, 1958b

Type species: *Cryphaeus boopis* Richter, 1909, by original designation.

Remarks: *Delocare* was revised by van Viersen (2013) who included species from Morocco and the Ardenno-Rhenish Mountains formerly assigned to *Saharops* Morzadec, 2001 and *Wiltzops* Basse, 2003 (both were regarded as junior subjective synonyms). Species from Spain placed in *Delocare* by Smeenk (1983) were transferred by van Viersen (2013) to *Dunopyge*.

Delocare sp.

Pl. 3: 1-3

Material: A single internal mould of a cephalon (EIA 764); from the lower Emsian in Réideschbaach.

Remarks: Only a tectonically deformed, internal mould of a cephalon is available which was recovered from a pelite. Assignment to *Delocare* is based on similarities to the type species, *D. boopis*, from the lower Emsian Gladbach-Schichten in the Eifel, with which it shares large tubercles concentrated on the widely rounded anterior glabellar lobe, and the strongly divergent S3 furrows.

Dunopyge Struve in Becker & Jansen, 1998

Type species: *Cryphaeus drevermanni* Richter, 1909, by original designation.

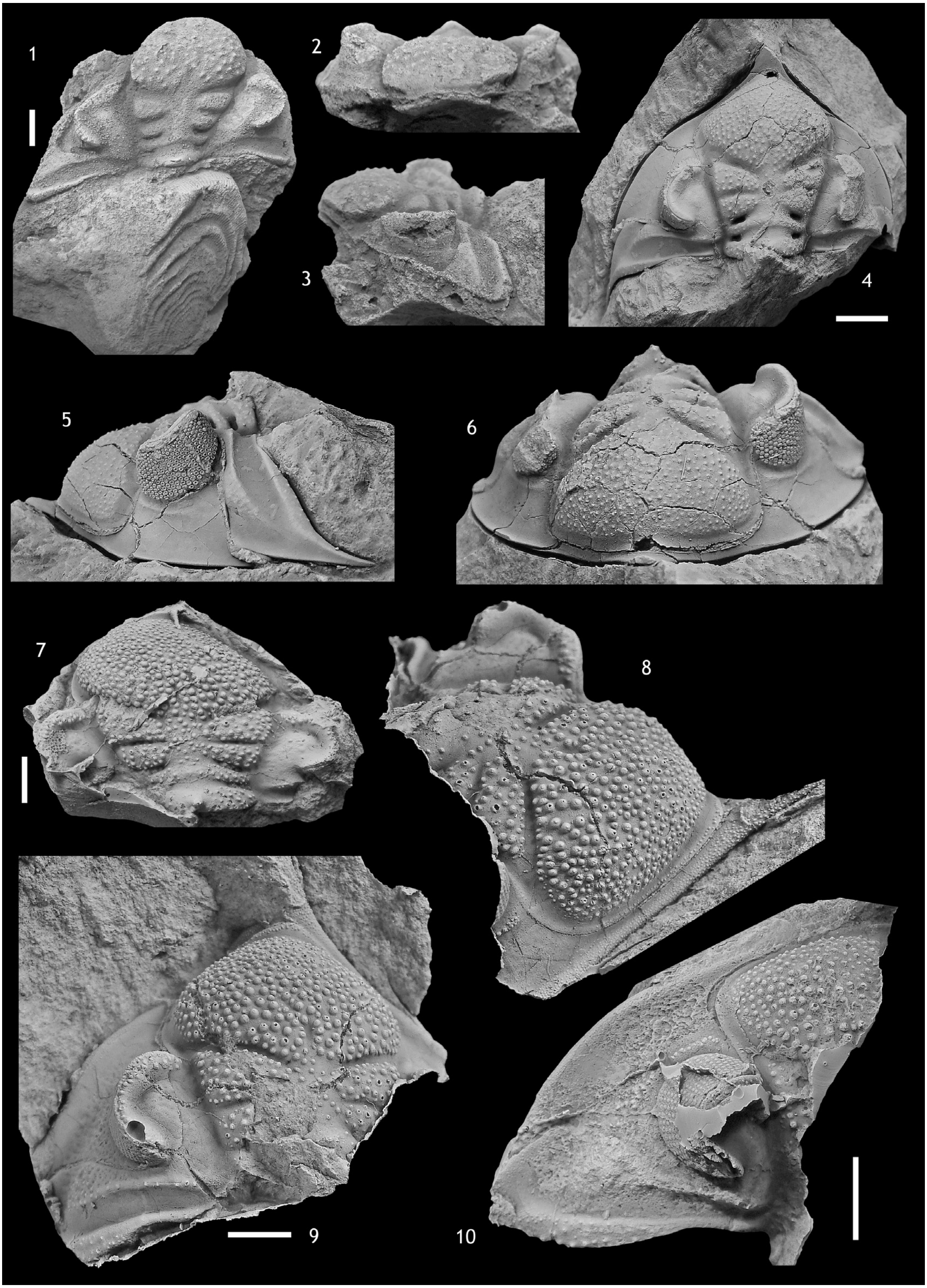
Remarks: *Dunopyge* was erected by Struve (in Becker & Jansen 1998) as a subgenus of

Plate 2

Rhenops australocustos Basse, Franke & Müller, 2006. - Lower Emsian; Réideschbaach, Luxembourg. **1, 2.** Silicone cast of a partial cephalothorax; EIA 751, **3.** Silicone cast of a pygidium; EIA 756, **4, 5.** Silicone cast of a partial cephalon; EIA 753, **6, 7.** Internal mould of a cephalon; EIA 757, **10.** Internal mould of a pygidium; EIA 755, **11, 12.** Internal mould and silicone cast of a pygidium; EIA 754a-b.

Asteropyginae gen. & sp. indet., possibly ***Rhenops australocustos*** Basse, Franke & Müller, 2006. - Lower Emsian; Réideschbaach, Luxembourg. **8, 9.** Silicone cast and internal mould of a hypostome; EIA 798a-b.

Scale bars indicate 5 mm.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Treveropyge but it received little attention until Basse (2003) granted it distinct generic rank and listed specimens from the Westerwald and the Eifel, Olkenbach, Lahn and Dill synclines. Basse & Franke (2006) favoured assignment of their new species *Pilletina oeslingiana* to that genus despite resemblances to *Dunopyge* noted by them, because the latter was deemed a stable concept in the Rhenish Mountains. Accepting the congeneric relationships of the Spanish species as proposed by van Viersen (2013), the genus encompasses a larger array of forms. In this light we have chosen to transfer *P. oeslingiana* from the problematic *Pilletina* to *Dunopyge*. Consequently, the absence of an occipital median node needs to be removed from the revised generic diagnosis of Basse & Franke (2006).

Dunopyge oeslingiana **(Basse & Franke, 2006)**

Pl. 3: 4-10, Pl. 4: 1-8

* 2006 *Pilletina*? *oeslingiana* Basse & Franke: 13, 21, 22, Pl. 2 Fig. 7 Pl. 4 Figs 1-8.

2006 *Pilletina oeslingiana* – Basse et al.: 250, Pl. 2 Figs 12-15.

New material: A single internal mould of a cranidium (EIA 760), four cephala (EIA 213, 760-762), two thoracic fragments (EIA 765, 800) and four pygidia (EIA 763, 766, 767-1-2); from the lower Emsian in Réideschbaach (type locality and horizon).

Remarks: This species is similar to the type species, *D. drevermanni* from the Gladbach-Schichten in the Eifel. The presence of single median spines on the occipital and post-cephalic axial rings, and single spines on the first two pairs of pygidial anterior pleural bands and serially homologous spines on the thoracic anterior pleural bands of *D. oeslingiana* are marked autapomorphies. *Dunopyge drevermanni* lacks a median occipital spine but it carries paired nodes or spines on the thoracic and pygidial axial rings and several more on the anterior four pygidial anterior pleural bands. The latter feature was not mentioned in the original description of this species by Richter (1909) but its presence in the pygidia figured by Basse & Franke (2006: Pl. 5 Figs 6-8) is unequivocal.

Along the margins of the pygidial pleural spines of *D. oeslingiana* there runs a narrow smooth band isolated ventrally and dorsally by close-set granules (e.g. Pl. 4 Fig. 8). Van Viersen & Kloc (2022) documented homologous structures horizontally, all along the exoskeletal fringe of an exceedingly well-preserved *Hollardops* specimen from southern Morocco and, in showing the band to house numerous pits (cf., e.g., Pl. 6 Fig. 9 in *Arduennella janseni*), inferred a sensory function from their distribution. They postulated that the pits housed setae, which would have allowed the trilobite to monitor movement in its surroundings and changes in current directions or even chemical composition of the seawater.

Van Viersen & Taghon (2020: 25, Fig. 3J) recorded a pygidial fragment from the Our Formation in Sankt Vith, which they tentatively attributed to *Dunopyge* or, less probably, *Pilletina*. As far as it is preserved, their specimen is indistinguishable from our pygidia of *Dunopyge oeslingiana* and herewith placed in that genus.

Braunops **Lieberman & Kloc, 1997**

Type species: *Kayserops obsoletus* Gandl, 1972, by original designation.

Braunops luxemburgensis **(Basse, Müller & Franke, 2006)**

Pl. 4: 9, 10

? 2006 *Braunops*? sp. – Basse & Franke: 24, 25, Pl. 5 Figs 10, 11.

e.p. * 2006 *Pilletina luxemburgensis* Basse et al.: 248-250, Pl. 1 Figs 8-11 [non Pl. 1 Figs 6, 7 = *Treveropyge*? sp.].

? 2006 *Braunops*? n. sp. 1 – Basse et al.: Pl. 3 Figs 21-25.

Plate 3

Delocare **sp.** - Lower Emsian; Réideschbaach, Luxembourg. **1-3.** Internal mould of a cephalon; EIA 764.

Dunopyge oeslingiana (Basse & Franke, 2006) - Lower Emsian; Réideschbaach, Luxembourg. **4-6.** Internal mould of a cephalon; EIA 213, **7.** Silicone cast of a cranidium; EIA 760, **8, 9.** Silicone cast of a cephalon; EIA 762, **10.** Silicone cast of a partial cephalon; EIA 761.

Scale bars indicate 5 mm.

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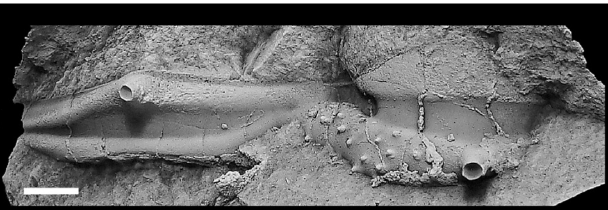

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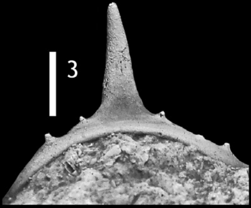

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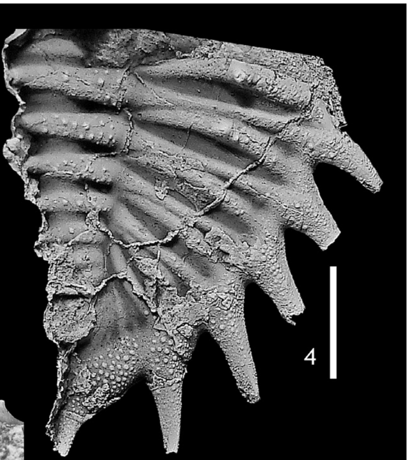

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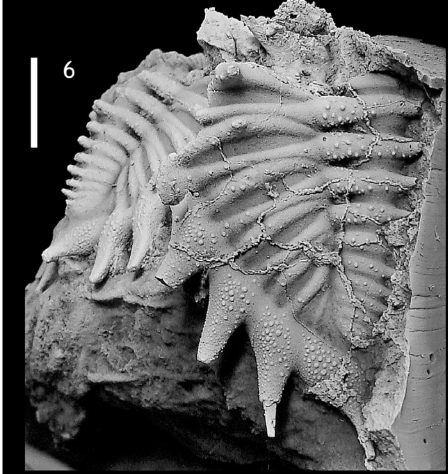

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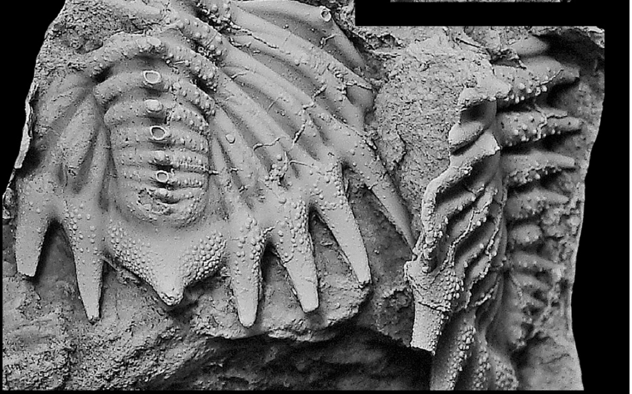

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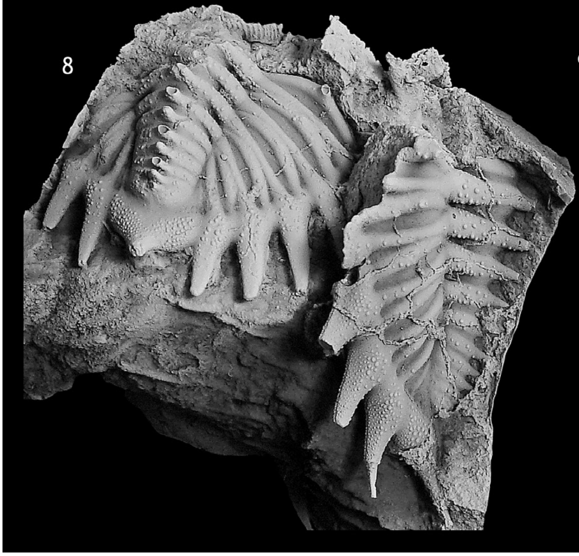

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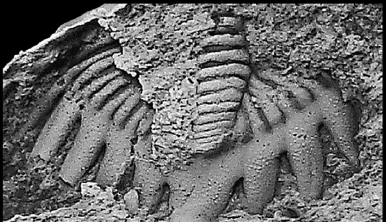

New material: Two pygidia (EIA 759, 797); from the lower Emsian in Réideschbaach (type locality and horizon).

Remarks: This species was established on pygidia and a cephalon. The material recorded here does not enable new observations. Van Viersen & Taghon (2020) pointed out resemblances between the paratype cephalon of *B. luxemburgensis* and that of *Treveropyge hellemondi* van Viersen & Taghon, 2020 from the Our Formation in Sankt Vith. The visual surface of *T. hellemondi* is smaller and contains fewer lenses. But the cephalon of *B. luxemburgensis* is probably more similar to *T. prorotundifrons* (Richter & Richter, 1943) from the Gladbach-Schichten in the Eifel. No pygidium of *Treveropyge* has been found in Réideschbaach and this casts some doubt on the reassignment of the cephalon to this genus. On the other hand, cephala of *P. luxemburgensis* appear to be rare and so too, *Treveropyge* could be a rare occurrence. We provisionally designate the single *B. luxemburgensis* cephalon *Treveropyge*? sp.

Pygidia tentatively assigned by Basse & Franke (2006) and Basse et al. (2006) to *Braunops* are not very dissimilar from the comparatively large holotype pygidium of *B. luxemburgensis* except for the pleural origin of the pleural spines and the shape of the median spine. Comparison to topotypical specimens of the type species, *B. obsoletus* from the lower Emsian of Spain, leads us to suggest that the differences between the pygidia of *Braunops*? n. sp. 1 of Basse et al. (2006) and *B. luxemburgensis* are related to intraspecific variation or body size. A large pygidium of *B. obsoletus* (Gandl 1972: Pl. 12 Fig. 5) is exceedingly similar to the large pygidium of *B. luxemburgensis* figured by Basse et al. (2006: Pl. 1 Fig. 8). Smaller pygidia of both species are also similar and often demonstrate a shift in the development of the pleural spines which originate from distally enlarged posterior pleural bands at the cost of the anterior pleural bands here. Likewise, their median spines are thinner (tr.) than those of the large pygidia.

Subfamily ACASTAVINAE Struve, 1958a

Alatacastava n. gen.

Type species: *Pelitlina*? *corbachoi* Basse & Müller, 2016, lower part of the Abadía Formation (Pragian–Emsian transition), Spain.

Etymology: Combination of alatus (Latin: winged), in reference to the far abaxial thoracic pleural projections, and the morphologically similar *Acastava*. Gender femininum.

Diagnosis: Acastavine with widely rounded cephalic outline. Firmly impressed frontal auxiliary impressions pli. Well-developed, abaxially enlarged (exsag.) L1. Wide (tr.) palpebral lobe and area. Close-set pits on librigenal field. Thoracic pleurae distally extended into long, dorsally flattened, gently subhorizontally curved, projections of uniform width (exsag.) except for distally tapered end carrying a small posterolateral spine. Pygidium with combination of long posterior border (sag.), four pairs of pleural spines sometimes with a small fifth (*A. smeenki*). Pygidial border furrow faintly impressed.

Other species: *Pelitlina smeenki* Lieberman & Kloc, 1997, La Vid Formation (lower Emsian), Spain; *Acastava faberi* Basse & Franke, 2006, lower Emsian, Luxembourg; *Alatacastava corbachoi fantasma* n. gen. et n. ssp, Abadía Formation (lower Emsian), Spain. In open nomenclature, *Pseudocryphaeus* sp. of Morzadec (in Le Menn et al. 1976), Reun ar C'Hrank Formation (lower Emsian, France; tentatively, a single "juvenile cephalon of *Rhenops babini* Morzadec, 1983" figured by Morzadec (1983: Pl. 7 Fig. 4), Le Fret Formation (upper Emsian), France.

Remarks: *Alatacastava* is erected to include some species previously assigned to *Pelitlina* Haas, 1968 and *Acastava* Richter & Richter, 1954. Haas

Plate 4

Dunopyge oeslingiana (Basse & Franke, 2006) - Lower Emsian; Réideschbaach, Luxembourg. **1.** Silicone cast of a partial thoracic segment; EIA 765, **2.** Internal mould of a pygidium; EIA 763, **3, 4.** Silicone cast and internal mould of a thoracic axial ring (posterior and dorsal views); EIA 800a-b, **4.** Silicone cast of a partial pygidium; EIA 766, **6-8.** Silicone cast of two pygidia; EIA 767-1-2.

Braunops luxemburgensis (Basse, Franke & Müller, 2006) - Lower Emsian; Réideschbaach, Luxembourg. **9.** Internal mould of a pygidium; EIA 759, **10.** Silicone cast of a pygidium; EIA 797.

Scale bars indicate 5 mm.

(1968) classified *Pelitlina* as a monotypic genus in Acastavinae. He united cephala and pygidia from the Pragian and lower Emsian (see Haas 1982 for updated chronostratigraphy) in the type species, *Pelitlina goltzi* Haas, 1968 from the Asian part of Türkiye. For the comparisons here we provisionally adopt Haas' concept of *P. goltzi* although a revision of that species would be more than timely. Lieberman & Kloc (1997) recognised a second species, *Pelitlina smeenki*, in Smeenk's (1983) *Acastava* n. sp. from the lower Emsian in the Asturo-Leonian Domain of the Cantabrian Mountains. Bignon et al. (2014) considered *P. smeenki* to be much closer to the asteropygine *Treveropyge* than to the acastavine *Pelitlina*. While this statement might be correct from a morphological perspective, the similarities between *P. smeenki* and *Treveropyge* are superficial and cannot be taken to support a close phylogenetic relationship between the two. Smeenk's (1983) cephala have comparatively small eyes separated from the lateral border by a broad (tr.) librigenal field and posteriorly separated from the axial furrow by a broad (tr.) palpebral area, as well as comparatively short pygidial pleural spines. None of these characters are shown by *Treveropyge*. Instead, they are symplesiomorphies of wide distribution among Siluro-Devonian acastids. *Pelitlina smeenki* has few (seven) axial rings, only the first four of which are consecutively tapered. This last character is a synapomorphy of a Devonian clade within Acastavinae that is inclusive of *Acastava*, *Acastellina* Richter & Richter, 1954 and the new genus, but not *P. goltzi*. Additionally, *P. goltzi* has rather small, anteriorly migrated eyes, consistently deep lateral and posterior border furrows that are continuous near the genal angle, continuous pygidial interpleural furrows, and the pygidial axis gently tapers posteriorly throughout. These features are in sheer contrast with *P. smeenki*.

Richter & Richter (1954) erected *Acastava* and selected *Cryphaeus atavus* Schmidt, 1907 from the Pragian of the Rhenish Massif as the type species. Basse & Franke (2006) emended the generic diagnosis and subdivided the genus into the *atava* and *schmidti* groups, while assigning their *Acastava faberi* to the former. Problems with the identity of the type species were previously pointed out by Franke (2010) and van Viersen (2013) who noted that it is only known from poorly preserved pygidia, and that the genus has been regarded by workers as inclusive of forms similar to the much better documented *Acastava schmidti* (Richter, 1909) (Fig. 3D) from the lower Emsian of the Rhenish Massif. The lectotype of *Acastava atava*, an internal mould of a pygidium, was figured by Richter & Richter (1954: Pl. 6 Fig. 81). It shares a widely rounded contour with *Acastava schmidti* and with *Acastava lerougei* van Viersen, 2013 from the upper Emsian of Belgium. Rudimentary pleural spines adorn the pygidial border of the lectotype of *Acastava atava* but it is unclear whether these were as clearly developed dorsally on the exoskeleton. Pleural spines are lacking fully on the pygidia of *Acastava schmidti* and *Acastava lerougei*. A pygidium of *Acastava* gr. *atava* from the Pragian of the Rhenish Massif illustrated by Basse (2003: Pl. 1 Fig. 4) does not appear to have pleural spines, or they are very rudimentary at most. Other *Acastava* specimens recorded from the lower to upper Emsian of the Ardenno-Rhenish Mountains (Basse 2003, van Viersen 2013) lack pygidial pleural spines. Basse & Franke (2006) recognised a series of chronospecies within *Acastava* characterised by progressive reduction of the pygidial pleural spines. This appears to be an ontogenetic feature that may or may not be expressed in large holaspides. Ramsköld & Edgecombe (1993) described pygidial pleural spines in penultimate meraspid and early holaspid stages of *Acastella*; these are retained in adulthood as faint traces of lappets or swellings on the lateral margins.

Franke (2010) took morphologic similarities between *Acastava* and *Acastellina* to suggest that either the latter arose from *Acastava* through paedomorphosis, or they are synonyms. *Alatacastava* shares with *Acastellina* the well-demarcated lateral cephalic and pygidial borders and the presence of a pygidial median spine, although Basse (2003) noted variability of this last feature between smaller and larger specimens of *Acastellina errabunda*. *Alatacastava* is less derived, however, in sharing "conservative" characters with *Acastava* such as the weakly differentiated transition between the glabella and the preglabellar field, the upturned anterior border of cephalon, and the shorter (sag.) postaxial field. *Acastava* differs from *Alatacastava* in having narrow (tr.) palpebral lobes, an adaxially weakly demarcated lateral border, narrow (exsag.) L1 lateral glabellar lobes, longer (sag., exsag.) more uniformly outlined occipital ring, and furthermore by the lack of frontal auxiliary impressions, pitted librigenal field, and medially protruding pygidial outline or median spine. Species of *Acastava* and *Acastellina*, as far as known from complete specimens (see, e.g., Basse 2003 and herein for photographs) have compacted thoracic pleurae, i.e., they lack the distal extensions that typify *Alatacastava*. Based on these comparisons, and despite the fact that the thorax of *Acastava faberi* remains unknown, we remove it from that genus. We unite it with the morphologically similar *Pelitlina smeenki*, *Pelitlina*? *corbachoi corbachoi* and *Alatacastava corbachoi fantasma* (all from Spain) in a new genus, *Alatacastava*.

The asteropygine *Minicryphaeus* from the Pragian to lower Emsian of southern Morocco (Morzadec 2001, Bignon et al. 2014, van Viersen & Kloc 2022) is similar to *Alatacastava* at first glance. Its species may have a broad (tr.) palpebral area, elongated dorsally flattened thoracic pleural projections like those of *A. corbachoi*, a pygidium with seven axial rings, four or five pairs of not particularly large pleural spines and a median spine. But the visual surface of *Minicryphaeus* is higher, the anterior border is not upturned and instead has an anterior projection, the preglabellar field is parabolic (sag.), the genal spines are robust and long with dorsally high bases, the cephalic outline is very different, the first five pygidial axial rings are steadily tapered and also the pygidial pleural segmentation pattern is typically asteropygine, the pygidial border furrow is firmly impressed, and there are well-developed pleural spines and a large median spine. Accepting the monophyly of *Minicryphaeus*, its species are best perceived as demonstrating a fair amount of convergence on *Alatacastava*. Other, superficial resemblances exist with *Destombesina* from the upper Emsian of Algeria and Morocco (Morzadec 1997, 2001) and the Lahn Syncline (Basse & Müller 2016). These chiefly involve reduced genal and pygidial pleural spines.

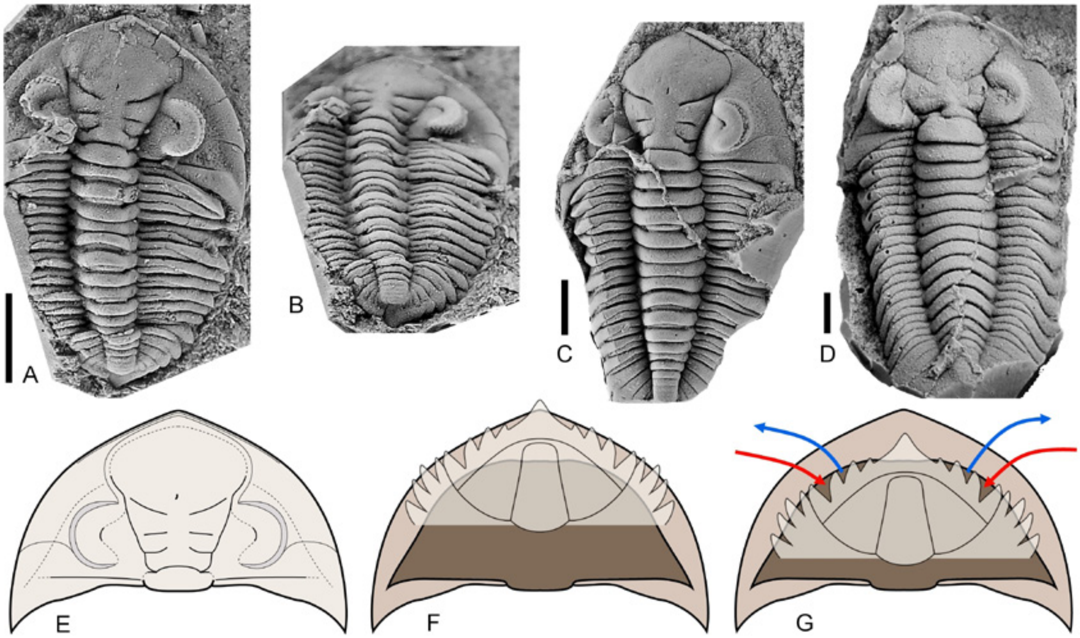

Fig. 3: Selected acastavine trilobites. *Alatacastava corbachoi corbachoi* (Basse & Müller, 2016). - lower part of Abadía Formation, Pragian–Emsian transition; Polentinos, Spain. **A, B:** Silicone cast of holotype incomplete specimen; SMF 88190.213. **C:** Silicone cast of paratype incomplete specimen; SMF 88190.214. **E:** Reconstruction of cephalon. **F:** Cephalon (ventral) and pygidium in locked state of coaptation. **G:** Cephalon (ventral) and pygidium in retracted state of coaptation. Note the slits between the pleural projections. Red and blue arrows indicate oxygenated seawater and excretion, respectively. *Acastava schmidti* (Richter, 1909). – Gladbach-Schichten, lower Emsian; Daun, Eifel. **D:** Lectotype incomplete specimen; NHMM 2011011 (silicone cast of SMF 79014b). Scale bars indicate 2 mm.

Morzadec (1983: Pl. 7 Fig. 4) illustrated what he regarded as a juvenile cephalon of *Rhenops babini* (deemed a species of *Hollardops* at present) from the upper Emsian of Brittany. Although this cephalon is poorly preserved as an internal mould, it is clearly not asteropygine. We believe that it is acastavine and that it may belong to *Alatacastava*.

Functional morphology: Van Viersen & Kloc (2022) reviewed coaptative devices of various phacopides (ordinal) and the functional morphology of 'intentional' mismatches between tagmata. They devised a basic rule pertaining to the relative proportions of the cephalon and the pygidium, which is that posterior to lateral outline of pygidium + pleural projections ≈ cephalic anterior to lateral outline. Using this argument, a dual mode of coaptation was proposed for a number of acastids and dalmanitids, among other trilobites, which encompasses a locked (fully enrolled) and a retracted state. The latter is achieved through withdrawal of the pygidium relative to the cephalon so that the pygidial pleural projections rest on the cephalic doublure, in the process creating slits between the projections which permit oxygenated sea water to flow internally, excretion, and antennae to protrude. This putative breathing device was considered by van Viersen & Kloc (2022) to be an advantageous trait that evolved, independently, in multiple phacopide clades during the Silurian and the Devonian. Both subspecies of *Alatacastava corbachoi* are known from articulated specimens. Of note are the small (sag., tr.) pygidial outline relative to the cephalon, compared to *Acastava* (Fig. 3D), and the additions of peripheral (pleural and median) spines to compensate total pygidial dimensions. Collectively, these features scarcely adhere to the basic rule of relative cephalic and pygidial proportions. However, the asteropygine-like macropleural thoracic segments of *Alatacastava* are also significantly wider than those of *Acastava*. The adaxial margin of the lateral cephalic doublure of *A. corbachoi fantasma* can be inferred from the internal mould of a cephalon (Pl. 5 Fig. 11), where it runs along the visual surface, coinciding with the lateral border furrow (as in, e.g., *Hollardops* (see van Viersen & Kloc 2022)). An impendent hypostomal condition is assumed based on the position of *Alatacastava* in Phacopida. Using these arguments, it becomes possible to reconstruct potential coaptative modes of *Alatacastava* (Fig. 3F, G) which reveal that the combination of thoracic and pygidial pleural spines and the pygidial median spine, would have supported a retracted state besides full enrolment. That is to say, *Alatacastava* probably independently developed a breathing device which is deemed here, a convergence on Asteropyginae.

Alatacastava corbachoi **(Basse & Müller, 2016)**

Subspecies assigned: *Alatacastava corbachoi corbachoi*, *Alatacastava corbachoi fantasma* n. ssp.

Diagnosis: Moderately small, tapered pygidial pleural spines. Thin pygidial median spine, about as long as posterior border (sag.), with moderately broad base.

Alatacastava corbachoi corbachoi **(Basse & Müller, 2016)**

Fig. 3A-C, E-G

1998 *Pelitlina*? *smeenki* Lieberman & Kloc – Basse: Pl. 3 Figs 5, 6.

* 2016 *Pelitlina*? *corbachoi* n. sp. – Basse & Müller: 147-149, Pl. 31 Fig. 320.

Material: Holotype incomplete specimen SMF 88190.213, paratype incomplete specimen SMF 88190.214; from lower part of Abadía Formation, Pragian–Emsian transition, Polentinos, Spain

Differential diagnosis: Upturned anterior border rim extending abaxially until area in front of eyes. Anterior three pygidial axial rings weakly tapering posteriorly (tr.).

Plate 5

Alatacastava faberi (Basse & Franke, 2006). - Lower Emsian; Réideschbaach, Luxembourg. **1.** Silicone cast of a cephalon; EIA 771, **2, 3.** Silicone cast of a cephalon; EIA 770, **4.** Silicone cast of holotype pygidium; EIA 107, **5.** Internal mould of a cephalon; EIA 768, **6, 8.** Internal mould of a cephalon; EIA 769, **7.** Internal mould of a pygidium; EIA 772. ***Alatacastava corbachoi fantasma*** n. gen. et n. ssp. - Abadía Formation, lower Emsian; Polentinos, Spain, **9.** Silicone cast of paratype incomplete specimen; DGO 24417, **10.** Silicone cast of holotype thoraco-pygidium; DGO 24416, **11.** Internal mould of paratype cephalon; DGO 24418, **12.** Internal mould of paratype pygidium; DGO 24419, **13.** Silicone cast of two paratype partial specimens (a, b) and paratype cephalon (c); DGO 24420a-c.

Scale bars indicate 2 mm.


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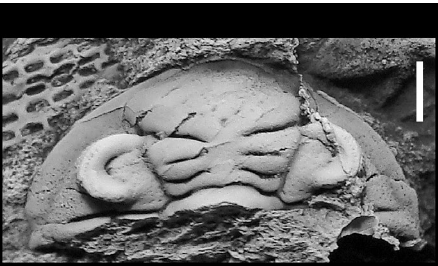
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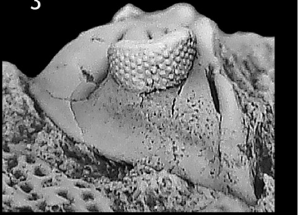
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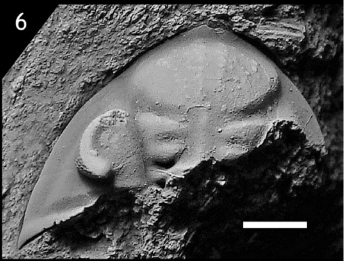
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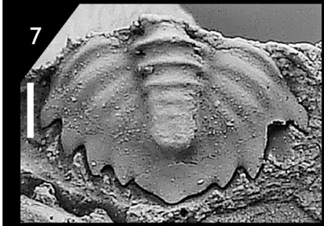
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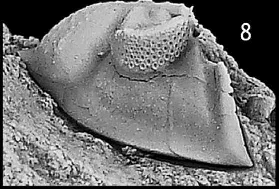
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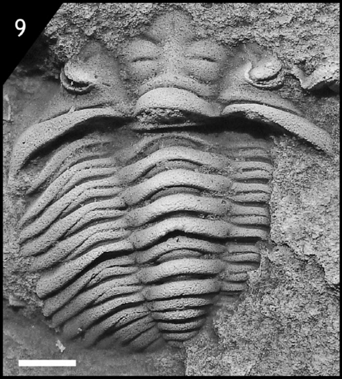
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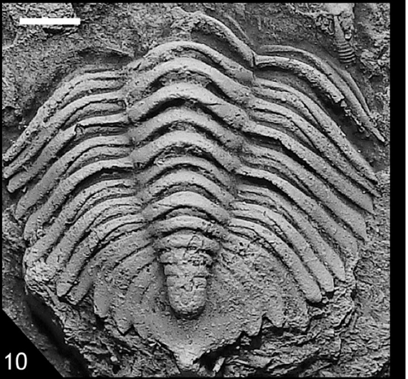
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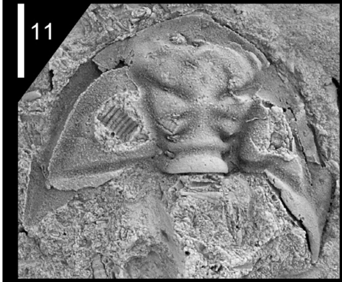
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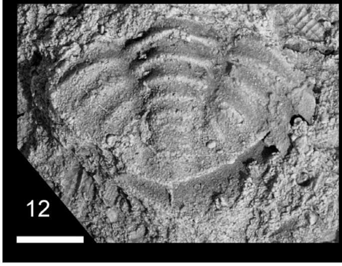
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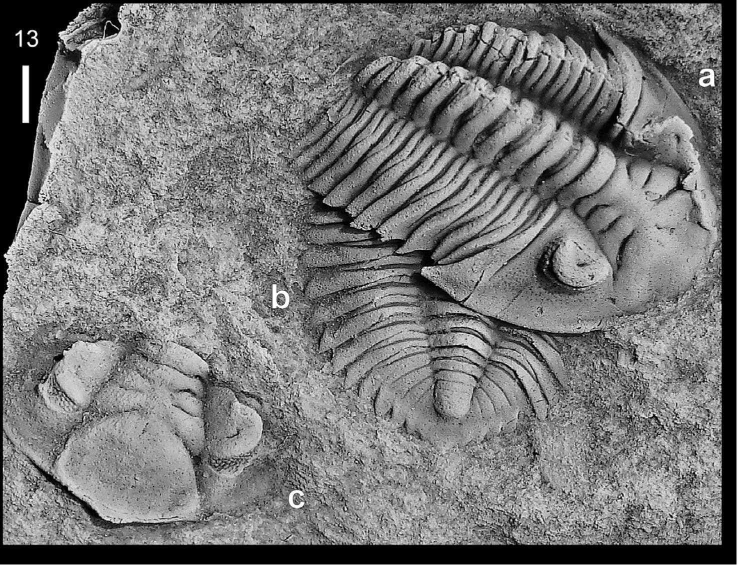
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a
b
c

Alatacastava corbachoi fantasma n. gen. et n. ssp.

Pl. 5: 9-13

Etymology: From φάντασμα (Greek: ghost), in reference to the draped shape of the thoracopygidium; appositionally.

Holotype: Thoracopygidium DGO 24416 (Pl. 5 Fig. 10).

Type locality: Outcrop on the northern outskirts of the village of Polentinos, Cantabrian Mountains, Spain.

Type horizon: Yellowish, decalcified siltstones in the lower Emsian Requejada Member of the Abadía Formation.

Paratypes: Articulated, partial to incomplete specimens DGO 24417, 24420a, 24420b, cephalon DGO 24420c, internal mould of a cephalon DGO 24418, internal mould of a pygidium DGO 24419; from the type locality and horizon.

Differential diagnosis: Upturned anterior border rim continuing until base of genal spine. Anterior pygidial axial ring about twice as wide (tr.) as fourth pygidial axial ring.

Remarks: *Alatacastava corbachoi fantasma* belongs to a late early Emsian trilobite fauna from the Requejada Member of the Abadiá Formation in Polentinos (Palentine Domain), for which a manuscript is in preparation by us. Smeenk's (1983) *Acastava* n. sp. (= *Pelitlina smeenki* Lieberman & Kloc, 1997) comes from the La Vid Formation in the Asturo-Leonian Domain, although he (Smeenk 1983: 419) reported the same species in the Palentine Domain without figuring or describing the specimens. Basse (1998) recorded *Pelitlina*? *smeenki* from the Abadía Formation near Polentinos but his specimens are different from the types in having four pairs of smaller pygidial pleural spines and a small median spine. Basse's specimens were later referred to a new species, *Pelitlina*? *corbachoi*, by Basse & Müller (2016). According to those workers, the type horizon is the lower part of the Abadía Formation (Pragian–Emsian transition). The new subspecies which is proposed here, comes from the mid- to late lower Emsian Requejada Member in a different locality in Polentinos. Despite the significant stratigraphic gap, both subspecies are fairly similar and differentiated by only few features.

Alatacastava faberi (Basse & Franke, 2006)

Pl. 5: 1-8

2004 *Acastava* cf. *atava* (Schmidt 1907) – Basse & Müller: Pl. 51 Fig. 670.
* 2006 *Acastava faberi* Basse & Franke: 20, Pl. 3 Figs 11-13.

New material: Four cephala (EIA 768-771) and a pygidium (EIA 772); from the lower Emsian in Réideschbaach (type locality and horizon).

Remarks: Basse & Franke (2006) described *A. faberi* on the basis of pygidia alone. We record the first cephala which are almost indistinguishable from the cephala of both *A. corbachoi* subspecies from Spain. Striking are the scar-like pmi and pli on the silicone casts of the external moulds from Réideschbaach. On internal moulds, corresponding pads are unobvious but relics of a well-developed complex of frontal auxiliary impressions are apparent frontally on the glabella. The contrary is the case on the internal mould of a cephalon of *A. corbachoi fantasma* (Pl. 5: 11) which does have scar-like pmi and pli and appears to lack pads anterior to these, although this could potentially be ascribed to different preservation. The pygidium of *A. faberi* is principally different from both subspecies of *A. corbachoi* in demonstrating a more broadly rounded (instead of angular) outline, and in having shorter, less tapered, distally truncated pygidial pleural spines.

Family HOMALONOTIDAE Chapman, 1890

Subfamily HOMALONOTINAE Chapman, 1890

Arduennella Wenndorf, 1990

Type species: *Homalonotus maillieuxi* Asselberghs, 1923, by original designation.

Plate 6

***Arduennella janseni* n. sp.** - Lower Emsian; Réideschbaach, Luxembourg. **1-4.** Silicone cast of paratype cranidium; EIA 773, **5-9.** Silicone cast of holotype pygidium; EIA 774.

Scale bars indicate 5 mm. Height of Fig. 9 is 5 mm.


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Arduennella janseni n. sp.

Pl. 6: 1-9

Etymology: Named after Ulrich Jansen, in recognition of his noted papers on Devonian palaeontology.

Holotype: Pygidium EIA 774 (Pl. 6: 5-9).

Type locality: Réideschbaach, Luxembourg.

Type horizon: Lower Emsian.

Paratype: Cranidium EIA 773; from the type locality and horizon.

Diagnosis: Long (sag., exsag.) preglabellar field; length equals about 0.4 of glabella anterior to S0. Homogenous dorsal profile (sag.) of pygidial axis, forming a straight line in lateral view. Anterior portion of pygidial axis broad and low, barely ascending above the adjacent parts of the pleural fields; widely M-shaped, posterodorsally projected rings; broad (sag., exsag.) inter-ring furrows. Posterior portion of pygidial axis increasingly ascending above the adjacent parts of the pleural fields.

Remarks: The material of *A. janseni* is recorded as silicone casts made of the external moulds. The outer layer of the mineralised exoskeleton is exfoliated in places, leaving taphonomic artefacts (pseudo-granules) on the right posterior part of the pygidial axis and patches on the cranidium. Van Viersen & Taghon (2020: Fig. 3H) figured an internal mould of a pygidium of *A. maillieuxi* which shows small punctures of similar distribution on the axis; they interpreted these as the remainders of pore canals extending through the exoskeleton and connected to pitted dorsal tubercles (*cf*. Størmer 1980, Dalingwater et al. 1999, Rustán et al. 2020). It follows that the pseudo-granules of *Arduennella janseni* are the remaining infillings of such canals. On the pygidial margin there is a narrow smooth band adorned with close-set, small pits which were probably the inset points of setae. Potentially homologous sensory apparatuses have been described in asteropygines (see remarks on *Dunopyge oeslingiana* above). Van Viersen & Kloc (2022) already expected a wider distribution of this feature in Devonian members of Phacopina, including homalonotids, but it was not yet known in a species of *Arduennella*.

The types of *A. maillieuxi* are affected by severe tectonic deformation with few exceptions. This is a weak premise when attempting to contrast their morphology with the new species but impossible to circumvent without a chance at recovering new material from the type locality (see van Viersen & Taghon 2020). The preglabellar field of *A. maillieuxi* appears to be much shorter (although this feature was poorly expressed in the polymorphic concept provisionally retained by van Viersen & Taghon 2020: Fig. 4), and the cylindrically vaulted (tr.) axis of the fairly well three-dimensionally preserved lectotype pygidium stands out markedly from the pleural regions. *Arduennella hainauensis* has a shorter preglabellar field, much more firmly impressed lateral glabellar furrows (at least on internal moulds), and the anterior portion of the pygidial axis ascends high above the pleural fields and comprises straight (tr.) rings.

Wenndorfia Sandford, 2005

Type species: *Homalonotus mutabilis* Koch, 1880, by original designation.

Wenndorfia plana (Koch, 1880) ssp.

Pl. 7: 1-8, Pl. 8: 7, 8, 10, 11

2006 *Parahomalonotus planus* ssp. – Basse & Franke: 18, Pl. 3 Fig. 10.

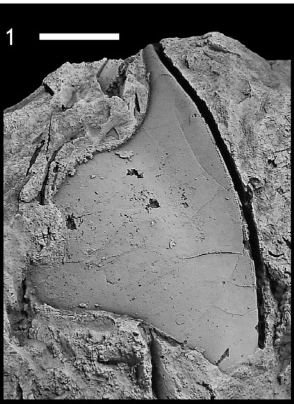
2006 *Wenndorfia plana* ssp. – Basse et al.: 244.

New material: A librigena (EIA 775), a thoracic segment (EIA 776) and two pygidia (EIA 132, 777, 784); from the lower Emsian in the Réideschbaach locality.

Plate 7

Homalonotidae. - Lower Emsian; Réideschbaach, Luxembourg. **1. *Wenndorfia plana*** (Koch, 1880) ssp., internal mould of a librigena; EIA 775, **2. *Wenndorfia plana*** (Koch, 1880) ssp., silicone cast of a partial pygidium; EIA 777a, **3, 4, 6, 8. *Wenndorfia plana*** (Koch, 1880) ssp., silicone cast and internal mould of a pygidium; EIA 132-ab, **5, 7. *Wenndorfia plana*** (Koch, 1880) ssp., internal mould of an incomplete thorax segment; EIA 776, **9-11. *Spiniscabrella* sp.**, silicone cast of a thoracic fragment; EIA 783, **12. *Spiniscabrella* sp.**, silicone cast of a cranidial fragment; EIA 779, **13. *Spiniscabrella* sp.**, silicone cast of a partial pygidium; EIA 784, **14. *Burmeisterella quadrispinosa*** Wenndorf, 1990, internal mould of a pygidium; EIA 778.

Scale bars indicate 5 mm.



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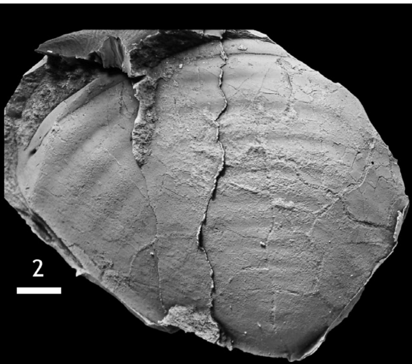

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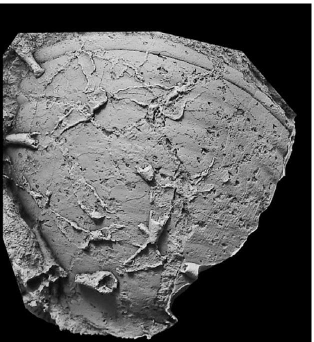

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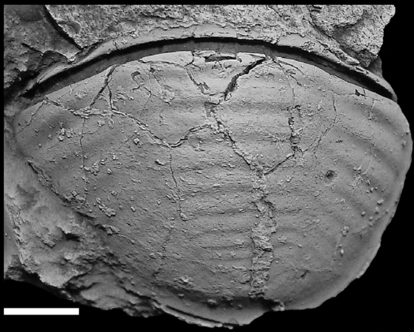

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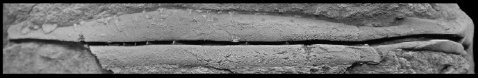

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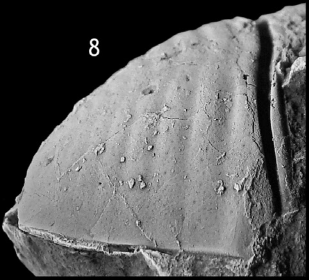

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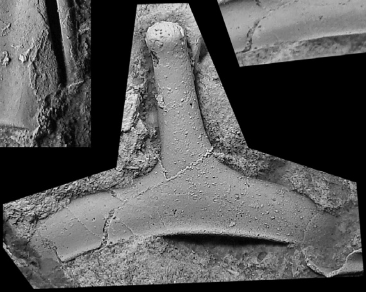

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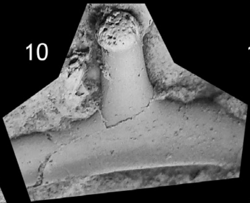

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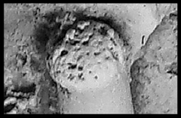

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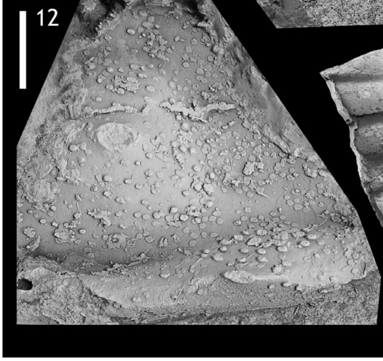

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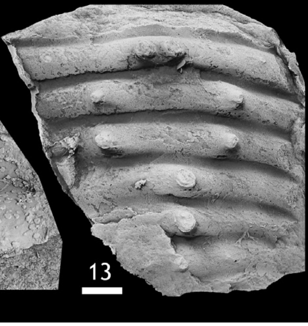

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Remarks: The specimens recorded here are in line with previous assignments to this species by Basse & Franke (2006) and Basse et al. (2006) and do not permit any further discussion on their identity at the subspecies level.

Spiniscabrella **Müller, 2005**

Type species: *Scabrella struvei* Schraut, 2000, by original designation.

Remarks: Müller (2005) erected *Interscabrella* and *Spiniscabrella* as subgenera of *Scabrellana* Harzhauser & Landau, 2021 (replacement name for the invalid *Scabrella* Wenndorf, 1990). Van Viersen & Prescher (2009) placed *Interscabrella* in synonymy of a revised *Spiniscabrella* of distinct generic rank, based on the putatively homologous pygidial dorsal spines of these taxa and the marginal tubercles and spines (respectively). Müller & Franke (2012) contrasted the pleural origins of the marginal spines of *Spiniscabrella* with the numerous tubercles or short thorns of *Interscabrella*, and pointed out that the origin of the median spine is marginal in *Spiniscabrella* whereas it is supramarginal in *Scabrellana* and *Interscabrella*. Using these arguments Müller & Franke (2012) proposed the retention of *Interscabrella* as a subgenus of *Scabrellana*. This implies that *Scabrellana* and *Interscabrella* form a clade that is sister to *Spiniscabrella*, for which no phylogenetic support was provided. There is no doubt that all three taxa are closely allied, and it is conservative to assume that *Scabrellana* is the stratigraphically oldest and plesiomorphic-most member. Until more is known, especially on the morphology of *Interscabrella* and the derivation of *Spiniscabrella*, and to avoid loss of information, we retain all three as distinct genera.

Spiniscabrella **sp.**
Pl. 7: 9-13

2005 *Scabrella* (*Spiniscabrella*) sp. – Müller: 16-17, Pl. 2 Fig. 8.
2006 *Scabrella* (*Spiniscabrella*) sp. – Basse & Franke: 13, Pl. 3 Fig. 9.
2006 *Spiniscabrella* sp. – Basse et al.: 248, Pl. 3 Fig. 30.
2012 *Spiniscabrella* sp. – Müller & Franke: Pl. 3 Fig. 3.

New material: Three cranidial fragments (EIA 779-781), two thoracic fragments (EIA 782, 783) and a partial pygidium (EIA 784); from the lower Emsian in the Réideschbaach locality.

Remarks: Only fragmentary material was recovered of this species that do not allow a more precise classification. They are the stratigraphically earliest records of the genus to date and likely represent a new species.

Burmeisterella **Reed, 1918**

Type species: *Burmeisterella neoelongata* Basse, 2007, replacement name for the invalid *Homalonotus* (*Burmeisteria*) *elongatus* Salter, 1865 (Basse 2007).

Burmeisterella quadrispinosa **Wenndorf, 1990**
Pl. 7: 14

2006 *Burmeisterella* cf. *quadrispinosa* – Basse et al.: 247, 248.

New material: A single internal mould of a pygidium (EIA 778); from the lower Emsian in the Réideschbaach locality.

Remarks: The discovery in Réideschbaach of a thoracic fragment of this species was previously mentioned by Basse et al. (2006), who were still uncertain about its identity. The internal mould of a pygidium recorded here corroborates assignment to *B. quadrispinosa*. This species was recently reported in the Our Formation in Sankt Vith (van Viersen & Prescher 2009, van Viersen & Taghon 2020).

High variability of the pygidial dorsal spine pattern of *B. quadrispinosa* was recognised by Wenndorf (1990) among specimens from the Rhenish Mountains and accepted as intraspecific variation. Van Viersen & Taghon (2020) characterised the pygidia from Sankt Vith as exceedingly spiny, often with two spines on a single pleural band instead of one. It would seem that the material from Réideschbaach shows the same pattern but the single available internal mould is worn and its morphology difficult to interpret with certainty.

Family ODONTOPLEURIDAE Burmeister, 1843

Subfamily ODONTOPLEURINAE Burmeister, 1843

Leonaspis **Richter & Richter, 1917**

Type species: *Odontopleura leonhardi* Barrande, 1846, by original designation.

***Leonaspis*? sp.**

Pl. 8: 1-6

2006 *Kettneraspis* sp. or *Leonaspis* sp. – Basse & Franke: 13, 25, Pl. 3 Fig 16.

2006 *Leonaspis*? sp. – Basse et al.: 252, 253, Pl. 3 Figs 31, 32.

New material: A librigena (EIA 785-2) and four cranidia (EIA 107, 388, 795, 796); from the lower Emsian in the Réideschbaach locality.

Remarks: The occurrence of an odontopleurine belonging either to *Kettneraspis* or the morphologically similar *Leonaspis* was recognised by Basse & Franke (2006) and our specimens are likely

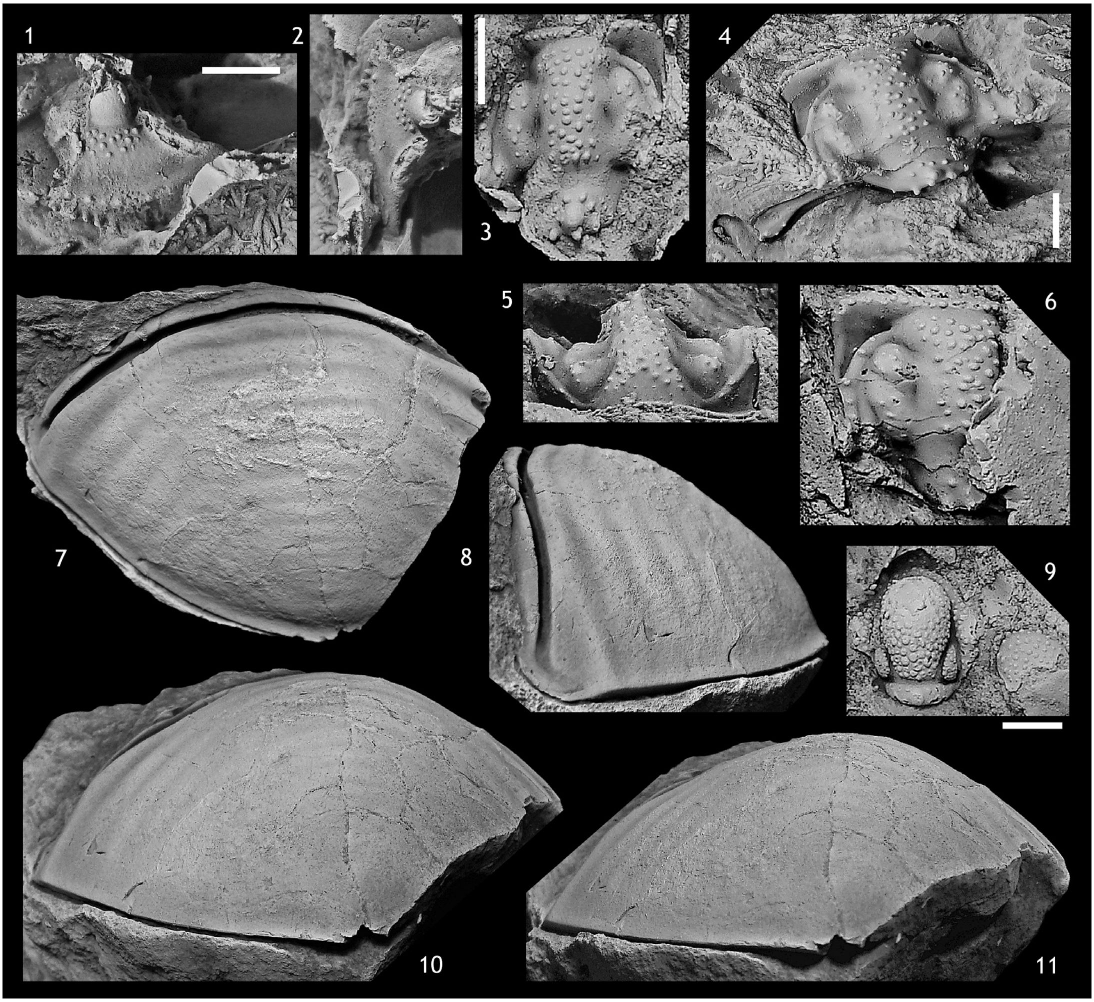


Plate 8

***Leonaspis*? sp.** - Lower Emsian; Réideschbaach, Luxembourg. **1, 2.** Silicone cast of a librigena; EIA 785-2, **3.** Silicone cast of a cranidium; EIA 795, **4-6.** Internal mould (4, 5) and silicone cast (6) of a cranidium; EIA 796a-b.

Wenndorfia plana (Koch, 1880) ssp. - Lower Emsian; Réideschbaach, Luxembourg. **7, 8, 10, 11.** Internal mould of a pygidium; EIA 777b [same individual as in Pl. 7 Fig. 2]. Pygidium is 35 mm long (sag.).

Cyphaspis* sp.** A ex. gr. ***hamidi Chatterton et al., 2006 - Lower Emsian; Réideschbaach, Luxembourg. **9.** Silicone cast of a cranidium; EIA 793a.

Scale bars indicate 2 mm.

conspecific. Basse et al. (2006) provided arguments to favour assignment of the Réideschbaach species to *Leonaspis* and these are accepted herein. To date, there is no consensus on apomorphies of *Kettneraspis* and *Leonaspis*. Characters commonly used to discriminate these genera have been criticised (van Viersen & Heising 2015) whilst primary importance of the number of pygidial interior border spines (two for *Kettneraspis* and four for *Leonaspis*) was reiterated by Holloway (2021). It will be argued elsewhere by one of us (A.V, work in progress), that the interior border spine number was defined during late ontogeny and that its use as a single distinguishing character is not without controversy.

Family AULACOPLEURIDAE Angelin, 1854

Subfamily OTARIONINAE Richter & Richter, 1926

Tribe OTARIONINI Richter & Richter, 1926

Cyphaspis Burmeister, 1843

Type species: *Phacops ceratophthalmus* Goldfuss, 1843, by designation under the plenary power (ICZN Opinion 1434).

Cyphaspis sp. A ex. gr. _hamidi_ Chatterton et al., 2006
Pl. 8 Fig. 9

cf. 1976 *Otarion* (*Otarion*) sp. – Morzadec (in Le Menn et al. 1976): 38, Pl. 4 Figs 9, 10.

cf. 1983 *Otarion* aff. *druida* – Smeenk: Pl. 21 Fig. 4.

2006 *Cyphaspis* sp. – Basse & Franke: Pl. 3 Figs 7, 8.

cf. 2016 *C.* aff. *druida* of Smeenk – van Viersen & Holland: 259, Fig. 9 [as a species of *Cyphaspis*].

New material: Three cranidia (EIA 792-794); from the lower Emsian in the Réideschbaach locality.

Remarks: A single *Cyphaspis* cranidium was figured but not described by Basse & Franke (2006). Smeenk (1983) recorded *Otarion* aff. *druida* from the Requejada Member of the Abadía Formation in Spain which bears exceeding similarities to the specimens from Réideschbaach. Van Viersen & Holland (2016) recognised Smeenk's material as an undescribed *Cyphaspis* species and one of the stratigraphically earliest known members of their informal *Cyphaspis hamidi* group, which also includes Morzadec's (in Le Menn et al. 1976) *Otarion* (*Otarion*) sp. from the lower Emsian of the Massif armoricain. Members of the group are characterised by a weakly vaulted cephalon covered with ubiquitous, closely spaced and uniformly sized ornament, exceedingly narrow interocular fixigenae, weakly inflated median glabellar lobe (as opposed to the peramorphic, anteriorly overhanging median glabellar lobe of primitive and many other *Cyphaspis* species), large spherical eyes, long (sag., exsag.), weakly inflated anterior cephalic border, and long, straight and occasionally very robust genal spines, among other features. Van Viersen & Holland (2016) underlined the artificial nature of their *Cyphaspis* groups and pointed out the possibility that the *hamidi* group is at least diphyletic. We have little doubt, however, about the close phylogenetic affinities of the early Emsian species considered here.

Family PROETIDAE Hawle & Corda, 1847

Remarks: Problems with the classification of Proetidae are legion. With the erection of Cornuproetinae, Richter, Richter & Struve (1959) ordained the nominal *Cornuproetus* as a principal wastebin taxon to house the majority of subfamilial diversity. All other, originally included genera have meanwhile been transferred to Eremiproetinae or Proetinae. Contents of Cornuproetinae continued to grow in haphazard fashion during the decades following its description. As many as 16 subgenera of *Cornuproetus* alone were recognised by Alberti (1969). Some of these are so poorly known that their use is impracticable and their validity questionable. Šnajdr (1980: 203) recognised the artificial nature of Cornuproetinae in expressing that "present taxonomic conception of this subfamily evidently includes complex of genera of different phyletic origin". Lütke (1980: 103, translated from German here) independently came to the same conclusion although he was more subtle in his phrasing, stating that "it cannot entirely be excluded yet that some of the assigned taxa (…) are convergent on the subfamily". No attempt has been made to validate Cornuproetinae from a phylogenetic standpoint. Until such time, we prefer to place its members in an undivided Proetidae. A proposal by Jell & Adrain (2003) to place Cornuproetinae in Tropidocoryphidae was criticised by Chatterton et al. (2006) and Brauckmann & Gröning (2011). We agree with those workers that Cornuproetinae should be placed in Proetidae if it were to be retained. Pillet (1969, 1973) proposed many proetid subfamilies some of which include genera traditionally associated with Cornuproetinae but those were either rejected (e.g. Owens 1973) or they have not received wide attention.

A single proetid species is known to occur in Réideschbaach which was identified by Basse & Franke (2006) as a member of *Paralepidoproetus* Alberti, 1981 exhibiting similarities to *P. acrodactylium* (Haas, 1968) from the upper Pragian to lower Emsian of Türkiye. The problem with *P. acrodactylium* is that it comprises at least two distinct species that may not belong to the same genus. For instance, the early Emsian cranidia from the type locality (Haas 1968: Pl. 27 Figs 7-9) have a weakly impressed anterior border furrow and rudimentary L1. A cranidium (Haas 1968: Pl. 27 Fig. 13) from another locality has a trench-shaped anterior border furrow, shorter anterior border (sag.) and firmly impressed lateral glabellar furrows isolating a teardrop-shaped L1. The only librigenae and pygidia of *P. acrodactylium* figured by Haas were collected from different stratigraphic levels and none came from the type locality. Their assumed conspecific relationships with the holotype are hardly convincing. In turn, the congeneric relationship of the types of *P. acrodactylium* with the type species of the genus, *P. chouberti* (Alberti, 1964) from southern Morocco, is equally questionable as will be argued below.

Paralepidoproetus chouberti is only known with certainty from damaged cranidia from the type locality (Alberti 1969: Pl. 7 Figs 4-6). Yet even these differ from one another in several important ways: e.g., the contrasting sagittal profiles of the anterior border and border furrow, and the very different course of the facial sutures with in particular β relative (exsag.) to δ. It is not inconceivable that one of Alberti's (1969: Pl. 7: Fig. 5) cranidia of *P. chouberti* belongs to *Timsaloproetus* Gibb & Chatterton, 2007 when comparing the sagittal profile of its preglabellar field, furrow and anterior border. Alberti (1964, 1969) reported a second species, *Paralepidoproetus fauremuretae*, as to co-occur with *P. chouberti* and so he was unsure which species to associate the pygidia with that were also found. Alberti (1964, 1969) did not specify whether all his specimens were collected from a single horizon. Thus, the incomplete holotype cranidium provides the only certain means of comparison. This renders *P. chouberti* an unfortunate choice of type species. The content of *Paralepidoproetus* is a matter of further debate. Alberti's (1969) cranidia of *P. fauremuretae* are similar to one another but they differ from *P. chouberti*, *P. acrodactylium* and the species from Réideschbaach, in having anastomosing ridges on the glabella, and a moderately strongly inflated anterior border bearing fairly numerous border-parallel terrace ridges that are visible dorsally. *Paralepidoproetus fauremuretae* likely belongs to a different genus.

Basse (1998), in describing trilobites from the Emsian of Spain, recorded the first complete specimens potentially to belong to *Paralepidoproetus*. One of these (*ibid*.: Pl. 1 Fig. 5) is fully articulated and has nine thorax segments. Van Viersen & Lerouge (2019) studied former cornuproetines with nine thorax segments which often combine a small overall body size with dorsal sculpture consisting of lirae organised according to a Bertillon pattern. Van Viersen & Lerouge considered the group to be polyphyletic and much larger than the exceptional status within the putatively chiefly 10-segmented Cornuproetinae granted by Richter et al. (1959) and other workers. For obvious reasons the amount of thorax segments of *P. chouberti* is unknown, but it is tentatively inferred from the sculpture and preglabellar morphology of the holotype cranidium that it had nine.

The species from Réideschbaach has nine thorax segments but we are reluctant to assign it to a poorly defined *Paralepidoproetus* based on superficial similarities of their cranidia alone. In fact, *Paralepidoproetus* itself could be synonymous with a range of largely similar, Early Devonian genera (see, e.g., Alberti 1969, Šnajdr 1977, 1980, Gibb & Chatterton 2007, van Viersen & Lerouge 2019) and we doubt whether it should be recognised at all. Of potential candidates to attribute the Réideschbaach material to, *Timsaloproetus* is currently probably the best choice seeing as the two differ only in a minor way that pertains to the inclination of the anterior border. Although we are not entirely satisfied with this solution, the classification of nine-segmented proetids evidently requires more work. This is primarily the result of a lack of taxonomic data (van Viersen & Lerouge 2019). We do not exclude the possibility that *Timsaloproetus* will be eligible for subdivision as a result of future studies.

Timsaloproetus Gibb & Chatterton, 2007

Type species: *Cornuproetus* (*Sculptoproetus*) *haasi* Alberti, 1971, by original designation.

Remarks: Gibb & Chatterton (2007) erected *Timsaloproetus* for a group of nine-segmented species with entire exoskeleton sculpted with fine subparallel terrace ridges, sometimes associated with defined pustules; anterior border downward-forward sloped and oriented at an angle of 20°-30° to horizontal; short to medially absent, and weakly convex preglabellar field; shallow anterior border furrow, little more than change in angle between anterior border and preglabellar field; pear- to violin-shaped glabella; occipital ring as wide (tr.) as maximum width of glabella farther forward; palpebral lobes set just in front of S0; comparatively long pygidial axis composed of articulating half ring, four rings, and terminal piece; postaxial lobe present immediately behind axis; up to four pleural furrows, though last two poorly defined, and only anteriormost pleural furrow distinct; pygidial border weak. The new species generally fits this diagnosis except for the 5 pygidial axial rings.

Although the generic concept of *Timsaloproetus* was fairly well outlined, the origin of the genus remains unknown. According to van Viersen & Lerouge (2019, 2021), the oldest species recognised at that time, *T. gibbae* van Viersen & Lerouge, 2019, occurs just above the base of the upper Emsian in southern Morocco, and almost nothing is known about lower Emsian diversity of *Timsaloproetus* or similar, nine-segmented proetids subsequent to noteworthy diversification of the group in the Pragian. Thus, *Timsaloproetus xenos* n. sp. from Réideschbaach, if correctly assigned to this genus, not only extends the known stratigraphic range of the genus into the lower Emsian but it also sheds new light on its early evolution. The morphology of the anterior border of *T. xenos* is striking in that it is slightly concave, rendering it distinct from most other *Timsaloproetus* species. The presence of a concave anterior border (= outer border furrow of Alberti 1969) is shared with Lochkovian and Pragian, nine-segmented species of *Lepidoproetus* Erben, 1951 and *Hollandiella* van Viersen & Lerouge, 2019, and the Pragian *Paralepidoproetus haentzscheli* (Alberti, 1967) should that generic assignment be retained. The apomorphic convex border is common among *Timsaloproetus* species from the upper Emsian. The plesiomorphic concave border is either retained or repeated by *Timsaloproetus weddigei* van Viersen & Lerouge, 2019 from the Eifelian of Ense in the Rhenish Mountains.

Timsaloproetus xenos n. sp.

Pl. 9: 1-16

2006 *Paralepidoproetus* cf. *acrodactylium* (Haas 1968) – Basse & Franke: 16-17, Pl. 3 Figs 3-5.
2006 *Paralepidoproetus* cf. *acrodactylium* (Haas 1968) – Basse et al.: 247, Pl. 1 Figs 1-5.

Etymology: From ξένος (Greek: stranger), in reference to its exotic status within the lower Emsian of the Ardenno-Rhenish Mountains; appositionally.

Holotype: Incomplete specimen EIA 337 (Pl. 9 Figs 2-6).

Type locality: Réideschbaach, Luxembourg.

Type horizon: Lower Emsian.

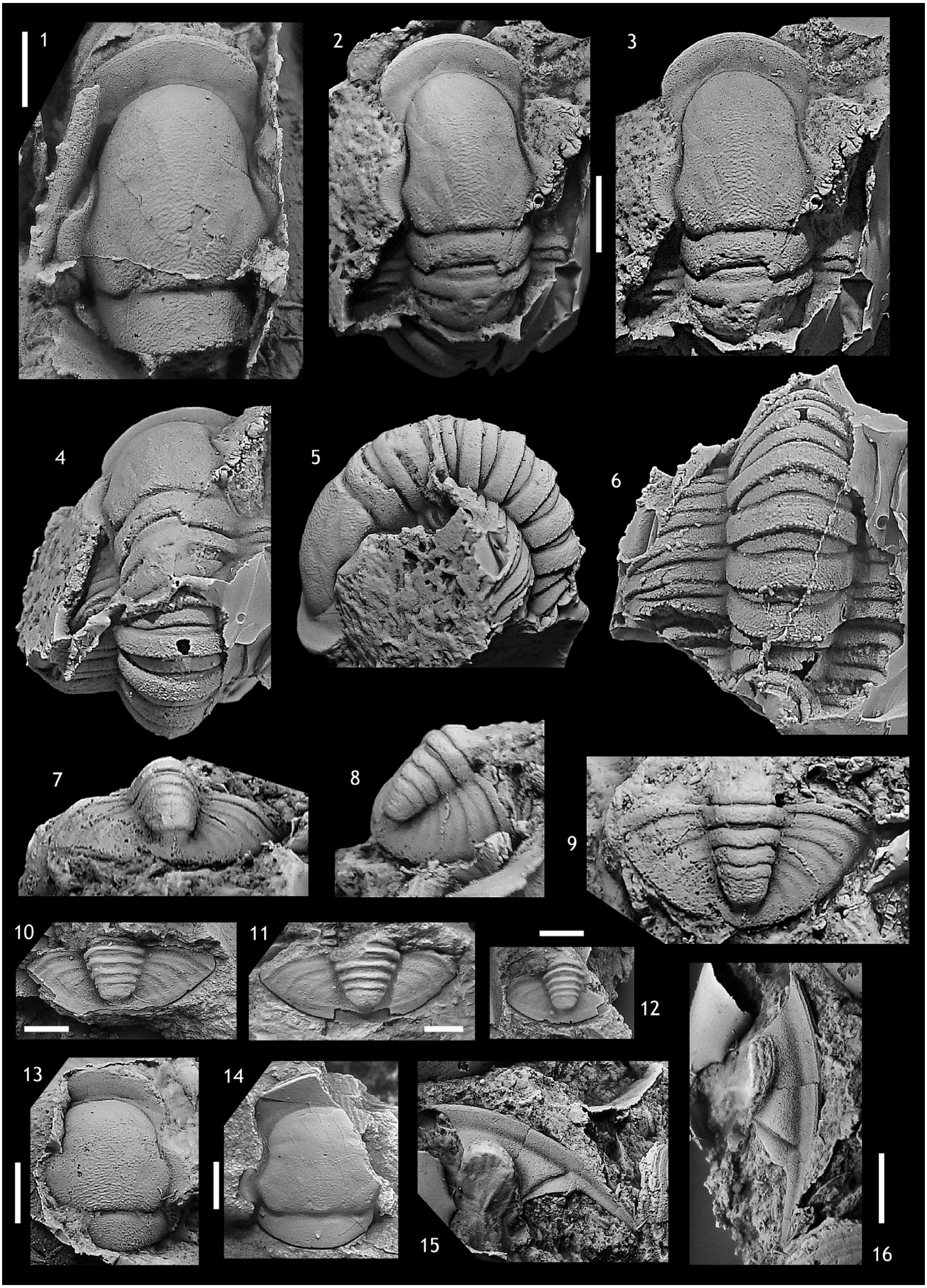
Paratypes: Seven cranidia (EIA 132, 785-1, 786-788; SMF 58646, 58647), three librigenae (EIA 137-1, 799; SMF 58791) and nine pygidia (EIA 114-1-2, 141, 385, 789-791, 792-1; SMF 58350, 58648); from the type locality and horizon.

Diagnosis: Anteriorly weakly dorsally convex or upturned anterior border of cranidium bearing three to four continuous terrace lines near margin and short, border-parallelly directed terrace lines. Faintly impressed, broad (sag., exsag.) anterior border furrow. Genal spine with furrow developed almost throughout. Four well-defined pygidial axial rings and a moderately weakly defined fifth.

Plate 9

***Timsaloproetus xenos* n. sp.** - Lower Emsian; Réideschbaach, Luxembourg. **1.** Silicone cast of paratype cranidium; EIA 785-1, **2-6.** Silicone cast of holotype incomplete specimen; EIA 337, **7-9.** Silicone cast of paratype pygidium; EIA 385, **10.** Internal mould of paratype pygidium; EIA 790, **11.** Internal mould of paratype pygidium; EIA 789, **12.** Internal mould of paratype pygidium; EIA 792-1, **13.** Silicone cast of paratype partial cranidium; EIA 786, **14.** Internal mould of paratype partial cranidium; EIA 787, **15, 16.** Silicone cast of paratype librigena; EIA 799.

Scale bars indicate 2 mm.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Description: Glabella broadly violin-shaped, carrying short terrace lines. Scar-like, weakly impressed but distinctive S1-S3 furrows. Occipital ring as high as glabella; lateral lobes weakly defined anteriorly by a short exsagittal furrow. L1 slightly protruding posteriorly from glabellar outline. Visual surface not particularly small for a *Timsaloproetus* species. Eye ridge inflated throughout. Anteriorly downsloped, weakly inflated preglabellar field. Genal spine about as long as librigenal field (exsag.). Thorax with medially developed pre-annuli that become narrower (tr.) on posterior segments. Lateral axial lobes undefined. Axial rings slightly ascend posteriorly (lateral view), carrying fine terrace ridges that are coarser and verge into forming granules on posterior margin. Outline of pygidium depicts a low parabola. Pygidium with widely M-shaped axial rings, a weakly defined fifth ring, and terminal piece. First four axial ring furrows running increasingly M-shaped; firmly impressed throughout. Three pairs of pleurae and a weakly defined fourth pair. Well-developed pleural furrows and slightly less marked interpleural furrows, approaching pygidial margin. Posterior parts of pleural and postaxial fields are gently sloped without indication of a pygidial border or border furrow. No terrace lines visible dorsally on the pygidial margin.

Remarks: Haas (1968) recorded *Sculptoproetus sculptus* (Barrande, 1852) from the lower Emsian Dede Formation in Türkiye, which was referred by Flick & Flick (2022) to their new species *Sculptoproetus* (*Macroblepharum*) *bithynicus*. Van Viersen & Lerouge (2019) placed *Macroblepharum* in synonymy of *Sculptoproetus* because they are exceedingly similar. According to Flick & Flick (2022), *Macroblepharum* is characterised by a pronounced, concave, often elongated course of the axial furrows between δ and γ, resulting in a comparatively slender, often elongated anterior glabellar lobe. These characters are fundamentally gradational, but they are also easily manipulated by tectonic deformation. Flick & Flick (2022) proposed the retention of *Macroblepharum* as a subgenus derived from *Sculptoproetus*. This classification creates meaningless paraphyly and therefore, it is not adopted here. The reconstruction of *S.* (*M.*) *bithynicus* (Flick & Flick 2022: Fig. 9) shows no differences with the axial furrows of *Timsaloproetus* (cf., e.g., Gibb & Chatterton 2007: Fig. 4.1) to which this species likely belongs. Roughly coeval *T. xenos* differs principally in having a shorter preglabellar field and a concave instead of a convex anterior border. The pygidium of *Timsaloproetus bithynicus* n. comb. is not from the type locality and for now, its affinity must be deemed uncertain.

4 Conclusions

The Réideschbaach locality has yielded an unusual trilobite fauna within the eurhenotypic subfacies of the Ardenno-Rhenish Mountains. Although the exact stratigraphic origin of the trilobite specimens remains unknown, the homalonotids *Burmeisterella quadrispinosa*, *Wenndorfia plana* ssp. and *Arduennella* collectively indicate an early, but certainly not latest early, Emsian age.

A survey of the literature reveals exchange of trilobite faunas between southern Laurussia and northern and peri-Gondwana to have occurred intermittently during the Early Devonian, and also more specifically in the early Emsian. Strikingly, members of *Alatacastava*, *Cyphaspis*, *Leonaspis* and *Timsaloproetus* seem to be absent elsewhere in the autochthonous parts of the Ardenno-Rhenish Mountains in strata of pre-upper Emsian age. This leads us to the preliminary conclusion that they are incursions from outside the basin that were unviable to persist here for a longer period of time. Potential palaeogeographic affinities are manifold although correlations with peri- and northern Gondwana appear to be the most parsimonious. Inconclusive stratigraphy and poorly outlined biotic and abiotic characteristics of potential events, however, render any attempt to place the Réideschbaach biota within a wider context premature. If anything, our study underlines once more the importance of speciation without gene flow to the evolution of Devonian trilobite faunas.

The restricted temporal and local, yet often abundant occurrences of members of *Arduennella* within various parts of the Ardenno-Rhenish Mountains, primarily underline their stenotopy. Thus, such taxa may afford valuable clues for future investigations into the exceptional conditions that sustained the Réideschbaach fauna. On a final note, the apparent absence in Réideschbaach of phacopids and dalmanitids, as regular components of early Emsian faunas in peri- and northern Gondwana (but also known to occur in the Hunsrück-Schiefer of the Rhenish Mountains), is striking. These taxa may yet be discovered here in stratigraphic levels not sampled at present.

It is difficult to issue meaningful statements about the taphonomy of the Réideschbaach trilobite fauna based on ex-situ finds of mostly disarticulated sclerites alone. However, the discovery of an outstretched, more or less articulated and intact exoskeleton of *Rhenops australocustos*, with in-situ hypostome and epizoans attached, excludes the possibility that this specimen at least, was transported over a long distance prior to final burial (*cf.* Speyer & Brett 1986).

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- abstracts in English, French and German, each 200-800 words long; new taxa names should be included in the abstract; the abstract should be precise and descriptive, in order to be reproduced as such in data bases; avoid vague sentences such as "three new species are described" or "species are compared to species already known"; include precise differential characters;
- text of the article, in the following order: Introduction, Abbreviations used, Material and methods, Results and/or Observations, Discussion, Acknowledgements, References. The arrangement of the parts "Results/Observations" and "Discussion" may be modulated according to the length and subject of the article; very long papers may include a table of contents;
- for systematic descriptions, each description should follow the order: name of taxon with author and date, synonymy, type material, etymology, material examined, distribution, diagnosis and/or description, remarks.
- description of geological features should include type level, type horizon, type locality. This order may be adapted according to the concerned groups: consult a recent issue of FERRANTIA;
- taxon names must be stated with author (and publication date, separated by a comma, where appropriate) at

least once at the first mention. At subsequent mentions of the same taxon, or other taxa of the same genus, the genus name may be abbreviated (*Rosa canina* L. to *R. canina*).

- use n. sp., n. gen., n. fam., etc. for new taxa;
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- references to illustrations and tables should be indicated as follows: (Fig. 1), (Fig. a, d), (Fig. 2a-d), (Figs 3; 6), (Figs 3-5; Tab. 2); (Tab. 1); for German texts use Abb. instead of Fig.
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Copies of all figures and tables should be included with the manuscript. They can be either included in the text at the correct locations with their legends or referenced in the text and included as annexes.

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References

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Høeg J. T. & Lützen J. 1985. - Comparative morphology and phylogeny of the family Thompsoniidae (Cirripedia: Rhizocephala: Akentrogonida) with description of three new genera and seven new species. Zoologica Scripta 22: 363-386.

Marshall C. R. 1987. - Lungfish: phylogeny and parsimony, in Bernis W. E., Burggren W. W. & Kemp N. E. (eds), The Biology and Evolution of Lungfishes, Journal of Morphology 1: 151-152.

Röckel D., Korn W. & Kohn A. J. 1995. - Manual of the Living Conidae. Volume 1: Indo-Pacific Region. Christa Hemmen, Wiesbaden, 517 p.

Schwaner T. D. 1985. - Population structure of black tiger snakes, *Notechis ater niger*, on off-shore islands of South Australia: 35-46, in Grigg G., Shine R. & Ehmann H. (eds), Biology of Australasian Frogs and Reptiles. Surrey Beatty and Sons, Sydney.

Gerecke R., Stoch F., Meisch C. & Schrankel I. 2005. - Die Fauna der Quellen und des hyporheischen Interstitials in Luxemburg unter besonderer Berücksichtigung der Milben (Acari), Muschelkrebse (Ostracoda) und Ruderfusskrebse (Copepoda). Ferrantia 41, Musée national d'histoire naturelle, Luxembourg, 140 p.

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