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A PSAMMOSTEID HETEROSTRACAN (VERTEBRATA: PTERASPIDOMORPHI) FROM THE EMSIAN (LOWER DEVONIAN) OF THE GRAND DUCHY OF LUXEMBOURG

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(3 figures)

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ABSTRACT. A fragment of a ventral disc of the head carapace of *Drepanaspis* sp. is reported for the first time from the Schuttbourg Formation of the Grand Duchy of Luxembourg. This formation is classically attributed to the upper lower Emsian (E1b). However, the fossil content of the locality (Merkholtz South-East quarry), including miospores, macroplants, bivalves, pterygotids, ostracodes and vertebrates, indicates a middle-upper Emsian age. This age is traditionally attributed to the overlying Clervaux Formation (Klerf-Schichten) of Luxembourg and western Germany (E2). This *Drepanaspis* record is the first record of a psammosteid heterostracan in the Ardenne Massif. *Drepanaspis* is otherwise known from the Pragian-Emsian of both SW England and western Germany.

KEYWORDS. Psammosteidae, *Drepanaspis*, new record, Schuttbourg Formation, Clervaux Formation.

RESUME. Un hétérostracé psammostéide (Vertebrata : Pteraspidomorphi) de l'Emsien (Dévonien inférieur) du Grand-Duché de Luxembourg. Un fragment de disque ventral de la carapace céphalique de *Drepanaspis* sp. a été récolté pour la première fois dans les Quartzophyllades de Schuttbourg du Grand-Duché de Luxembourg. Cette formation est habituellement attribuée à la partie supérieure de l'Emsien inférieur (E1b). Cependant, l'assemblage fossile de la localité (carrière sud-est de Merkholtz), qui comprend des miospores, des plantes, des bivalves, des ptérygotides, des ostracodes et des vertébrés, conduit à un âge emsien moyen à supérieur (E2), âge traditionnellement attribué aux couches sus-jacentes, les Schistes de Clervaux (Klerf-Schichten) du Luxembourg et d'Allemagne occidentale. Cette localité à *Drepanaspis* correspond à la première mention d'un hétérostracé psammostéide dans le Massif ardennais. *Drepanaspis* est connu dans le Praguien et l'Emsien du sud-ouest de l'Angleterre et de l'Allemagne de l'ouest.

MOTS-CLES. Psammosteidae, *Drepanaspis*, nouveau gisement, Formation de Schuttbourg, Formation de Clervaux.

1. Introduction

The lithostratigraphic subdivisions of the Lower Devonian of the Ardenne Massif in Belgium and Luxembourg have long been wrongly attributed to stages, or subdivisions of stages, in absence of accurate biostratigraphic controls. Among these attributions, mentions such as "E1b" or "E2" have to be regarded as lithostratigraphic formations rather than Emsian chronostratigraphic units. Among these formations, the dark-coloured shales and quartzites of the Schuttbourg Formation ("Quartzophyllades" de Schuttbourg) of the Neufchâteau Synclinorium, Ardenne Allochthon in Luxembourg are traditionally attributed to the upper lower Emsian (E1b in the regional stratigraphical scale: Lucius, 1950; Maquil *et al.*, 1984). They overlie the Stolzembourg Formation (E1a: dark grey or blue-grey shales with interbedded quartzite layers), and underlie the middle Emsian Clervaux Formation (E2: red or variegated shales with quartzite layers). The Schuttbourg Formation is partly equivalent to the Vireux Formation of the Dinant Synclinorium, Ardenne Allochthon in Belgium (VIR in Bultynck & Dejonghe, 2002).

After the unconfirmed mention of bony elements in the lower Emsian of Luxembourg by Asselbergs (1913), Bordet (1939), and Lucius (1950), the discovery of brachythoracid placoderm remains in the upper Emsian has yielded the first verified record of a vertebrate in the Lower Devonian of the country (Delsate, 1997; Blieck *et al.*, 1998). So, the discovery

of a psammosteid heterostracan in the Schuttbourg Formation constitutes the second verified record of vertebrates in the Lower Devonian of Luxembourg, and the first record of psammosteids in the Ardenne Massif. This taxon is indeed well known in the Lower Devonian of England in the West, and in the Lower Devonian of Germany in the East, but surprisingly was unknown in the Ardenne Massif, both in Belgium and Luxembourg.

Figure 1. Location of the Merkholtz South-East quarry (008), SE of Wiltz, and of the Consthum "Rinnen" quarry (007), ENE of Wiltz, Luxembourg.

A group of ancient quarries lies along the Wiltz river, a few kilometers SW of Lellingen (Fig. 1), where one of the brachythoracids was found (Delsate, 1997). The material described here comes from the Merkholtz South-East quarry where the "quartzophyllade" beds are subvertical. The sediments of this quarry are traditionally attributed to the lower Emsian Schuttbourg Formation (E1b), although the palynological study of Steemans *et al.* (2000) indicates a younger, middle to upper Emsian age. This discrepancy deserves some comments.

Gosselet (1885, p. 276-278) defined the "Quartzophyllades de Schuttbourg" as a sequence of grey-blue to dark grey, thick, quartzose sandstone layers and quartzose phyllites, where the sandstones may reach up to one third of the whole. He (Gosselet, 1885, p. 269-276) defined the "Schistes rouges de Clervaux" as a series of quartzose sandstones (mostly in its lower part) and coarse-grained shales (mostly in its upper part), being greenish, grey, grey-green, wine-red, brown-red, and violaceous; red colours are unconstant in the whole series, and they may characterise its base (Faber, 1984) or be more frequent in its uppermost part. The geological map (Bintz, 1966; Bintz & Maquil, 1992) indicates the Merkholtz South-East quarry in the "E1b Formation de Schuttbourg", after the field observations and geometrical extrapolations of Lucius (1950). The latter author gives a lower Emsian age for E1b, and a middle Emsian age for the Clervaux Formation (E2), which is several kilometers far from the Merkholtz South-East quarry on the geological map. Our sample E1B128 comes from a 30 cm thick violet coloured bank within a rather variegated series, on a promontory between the two eastern excavations of the quarry, and most probably in the uppermost part of the Schuttbourg Formation (A. Faber, pers. comm.). The lithofacies of this bank, with greenish and brown-yellow colours due to diagenetic oxidised conditions, does not allow to attribute it to the Clervaux Formation which, in this area, is made of red and wine-red shales, grey sandstones and shales, white quartzites, green and variegated sandstones and shales, as well as banded shales. The Merkholtz South-East quarry is made of a succession of several excavations within the Schuttbourg Formation, and may eventually extends up to the Schuttbourg-Clervaux formations boundary. However, the Merkholtz South-East quarry layers seem to be underlying the typical facies of the Clervaux Formation. In this area, the tectonics and lithological correlations are complex; the excavations have been abandoned for a long time; no precise, recent lithostratigraphical study has been processed; and it is difficult to attribute an isolated bank or a small portion of an excavation to either formation, taking into consideration that the Schuttbourg Formation is supposed to be 1000m thick.

A sample from the same layer as E1B128 has been chemically prepared for palynomorphs. It appeared to be rich in organic matter; however, it is highly carbonised, and it needed several re-oxidations. This sample is poor in palynomorphs. Nevertheless, the following stratigraphically significant species have been observed : *Acinosporites lindlarensis* Riegel 1968, *Apiculiretusispora brandtii* Streel 1964, *Dibolisporites echinaceus* (Eisenack) Richardson 1965 emend. McGregor 1973, *Dibolisporites wetteldorfensis* Lanninger 1968, *Emphanisporites zavallatus* Richardson *et al.* 1982 var. *nodosus* Steemans 1989, *Rhabdosporites minutus* Tiwari & Schaarschmidt 1975. Such a miospore assemblage is typically Emsian in age. Because of the occurrence of *R. minutus* and *A. lindlarensis*, it may be attributed to the Min interval biozone of the FD assemblage Miospore Zone (Streel *et al.*, 1987, 2000). Younger taxa like *Hystricosporites* spp. and *Ancyrospora* spp., which characterize the uppermost part of the Emsian, are absent. However, owing to the bad preservation of palynomorphs, and the low diversity of the assemblage (mostly composed of morphologically simple forms such as *Retusotriletes* and *Apiculiretusispora*), a younger, early AP Miospore Zone age cannot be excluded; and our sample would thus be middle/upper Emsian in age, without reaching the uppermost Emsian (for a revised dating of Emsian biozones, see Streel *et al.*, 2000).

The sample 11 of Steemans *et al.* (2000) from the Merkholtz South-East quarry was collected in another excavation, West of the *Drepanaspis* locality, and is supposedly younger than the *Drepanaspis*-bearing layer. It has yielded the following miospores: *Acinosporites lindlarensis*, *Apiculiretusispora plicata*, *Dictyotriletes*

subgranifer McGregor 1973, *Dibolisporites wetteldorfensis*, *Emphanisporites annulatus* McGregor 1961, *E. rotatus*, *Rhabdosporites minutus*, and *Verrucosisporites polygonalis* Lanninger 1968. This assemblage (FD to early AP Miospore Zones: Steemans *et al.*, 2000) is more indicative of the middle and upper Emsian than the lower Emsian.

So, it seems more probable that the *Drepanaspis*-bearing sample E1B128, which comes from the upper part of the Schuttbourg Formation, has a middle Emsian age after the palynological content of this part of the sequence, although the Schuttbourh Formation is lower Emsian in age in its type-locality after its invertebrate content (Gosselet, 1885; Lucius, 1950; Faber, 1984). Meanwhile, the palaeontological record is very scarce as compared to the formation thickness, creating large intervals without fossils. Miospore biozones have not yet been accurately calibrated with regard to the lower, middle, and upper subdivisions of the Emsian. Therefore, results based upon invertebrates and miospores cannot be inter-correlated until the respective biostratigraphic scales have been correlated to the stratotype subdivisions of the Emsian, currently under progress.

All material mentioned or described here belongs to the National Museum of Natural History of Luxembourg under the registration prefix E1B.

Nomenclatorial note

The lithostratigraphical unit "Schistes rouges de Clervaux" was introduced by Gosselet (1885, p. 269; also Gosselet, 1888, p. 371: "schistes de Clervaux"). This nomenclature has been used in German by Richter (1919, p. 51) under "Klerfer Schichten". [However, it must be mentioned here that "Schichten" in German is the translation of "couches" in French (beds or layers in English), the translation of "schistes" being "Schiefer".] It was confirmed by Kutscher (1958, p. 142: "Klerfer Schichten, Ems-Stufe, Unter Emsium"). The German name of the city of Clervaux is "Clerf" or "Klerf", the corresponding adjective being "Clerfer" or "Klerfer". In German, Clerf (or Klerf) is for both the city and the river which flows through it; however, in French, the city name is "Clervaux", and the river name is "la Clerve". So, the name "Couches de la Clerve" or "Couches bigarrées de la Clerve" for the lithostratigraphical unit has been erroneously used by Blieck *et al.* (1998, fig. 1 and p. 208), and it is corrected herein under "Formation de Clervaux" in French, "Clervaux Formation" in English, and "Klerfer Schichten" or better "Klerf-Schichten" in German. [This nomenclatorial note is mostly due to Dr. J. Godefroid, IRSNB, Brussels, Belgium.]

2. The fossil assemblage

Apart from the vertebrate element, the Merkholtz South-East quarry has yielded plant (including miospores, see above), bivalve, pterygotid and ostracode remains. Some specimens of the pteridophyte *Drepanophycus spinaeformis* Göppert 1852 (E1B159 and E1B158) were found in the Merkholtz quarry. This species has already been reported by Lippert (1939) from the Clervaux Formation (Klerf-Schichten, E2) of Irrhausen near Neuerburg (Germany), not far from the Luxembourg border.

The «quartzophyllade» lithology and the abundant plant remains make the Merkholtz South-East quarry sediments poor candidates for a conodont record, and no trilobites have been found in the explored quarry yet. Lippert (1939) has reported Bivalvia attributed to various "*Modiola*" species from the Clervaux Formation of Zweifelscheid and Irrhausen near Neuerburg. *Grammysia*-like bivalves, more probably *Parallelodon* and *Cypricardinia*, are present in the Merkholtz quarry (unnumbered material). These bivalves are biostratigraphically uninformative. Lippert

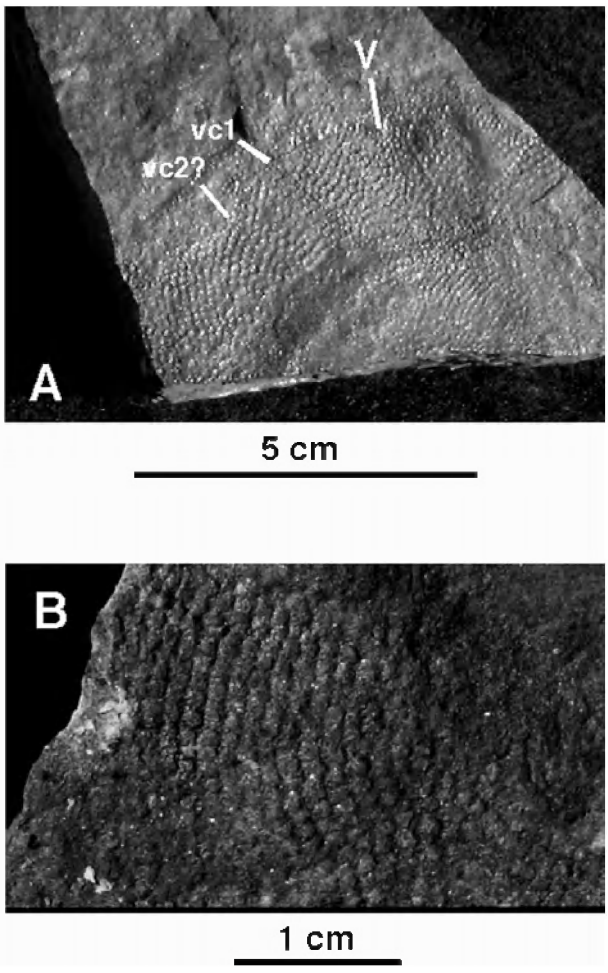

Figure 2. *Drepanaspis* sp., from the Merkholtz South-East quarry, Luxembourg; middle-upper Emsian (Lower Devonian) (specimen E1B128). External mould of the anterior part of a ventral disc (A), with detail of the ornamentation (B). Abbreviations: V - V-shaped pattern of the tubercles at the anterior median edge of the plate; vc1, vc2? – first and possibly second ventral sensory lines.

(1939) reported remains of Pterygotidae (among them abdominal segments) from the Clervaux Formation of Zweifelscheid and Irrhausen. Such pterygotid remains have been recovered from Merkholtz (E1B147 a&b and E1B148 a&b). Finally, rare plurimillimetric and poorly preserved specimens of Ostracoda seem attributable to Aparchitidae and Leperditellidae. Lippert (1939) reported *Leperditia klerfia* Mauz from the Clervaux Formation of Zweifelscheid.

So, it may be concluded that both macroplant and animal remains of the Merkholtz South-East quarry are more similar to the fossiliferous assemblage of the middle-upper Emsian Clervaux Formation (E2) than to the lower Emsian Schuttbourg Formation one (E1b); but their biostratigraphical value is not conclusive as to a middle Emsian age. This is in agreement with the palynological content which is middle-upper Emsian (Steemans *et al.*, 2000; and this study).

3. Systematic palaeontology

Subphylum Vertebrata Linnaeus, 1758
Class Pteraspidomorphi Goodrich, 1909
Subclass Heterostraci Lankester, 1868
Order Pteraspidiformes Berg, 1937
Family Psammosteidae Traquair, 1896
Genus *Drepanaspis* Schlüter, 1887
Drepanaspis sp.

Description. This taxon is represented by a 70 x 45 mm wide fragment of a bony plate (specimen E1B128 of the Natural History Museum of Luxembourg). It is preserved as an external natural mould. Transferred on a silicon replica, this fragment shows numerous eroded tubercles roughly aligned parallel to the natural edge of the plate (Fig. 2). There are nearly 8.5 tubercles per cm. They are grouped into two distinct areas, that is, an outer, ca. 20 mm wide area of larger, closely packed tubercles, and an inner area of smaller and more worn tubercles. As a consequence of their bad preservation, all the tubercles have an outer smooth surface, with no apparent fine ornament. Both areas are separated by a gentle slope which corresponds to a growth stage of the bony plate. Such an area of relief is also seen at the outer edge of the plate. All these features correspond to the fragment of a median plate of the head carapace of *Drepanaspis* as described by, e.g., Gross (1963). The specimen E1B128 shows a small region where the tubercles have a V-shaped pattern which probably corresponds to the anterior median area of the ventral median plate (= ventral disc; Fig. 3: v). This V-shaped pattern would indicate the symmetry plane of the plate (Fig. 2: V). On the left side of this symmetry plane, traces of at least two sensory canals are visible under low-angled light; they seem to correspond to the «ventrale Sinneskanäle» vc1-vc2 of Gross (1963, fig. 1O, 2H, and 3U) (Fig. 2: vc1, vc2?). However, the pattern of canals of the dorsal and ventral discs is very similar in both plates, and can hardly be used to separate them.

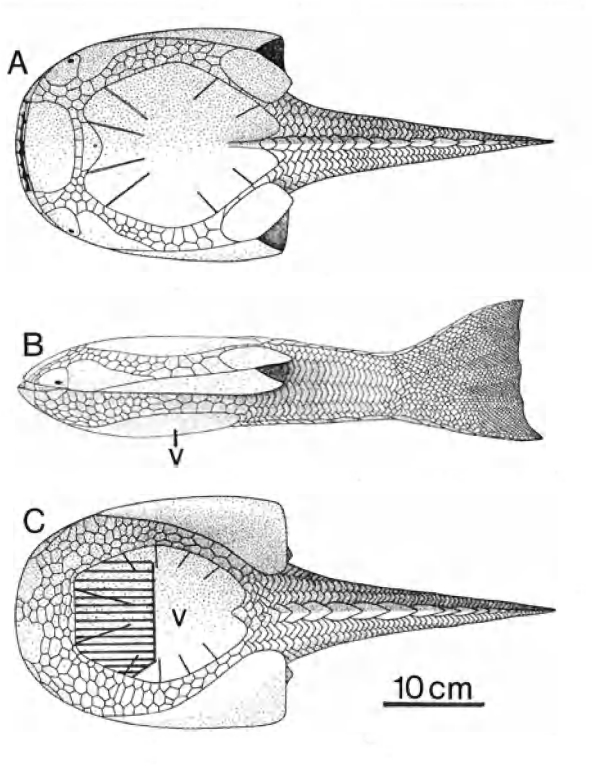

Figure 3. Reconstruction of *Drepanaspis gemuendenensis* Schlüter after Gross (1963, fig. 10A-B and 11A), in dorsal (A), left lateral (B), and ventral (C) views, with location of the anterior part (hatched) of the ventral disc (v) corresponding to the specimen of figure 2A (front to the left).

Discussion. *Drepanaspis* is a psammosteid genus classically found in the Pragian and Emsian of Cornwall, SW England, and of the Rhenish Slate Massif (Rheinisches Schiefergebirge), western Germany (Tarlo, 1965). The species *Drepanaspis lipperti* Gross is reported from the Clervaux Formation (Klerf-Schichten, E2) of Enzbach, near to Zweifelscheid, and Willwerath, Germany, east of the Grand Duchy of Luxembourg (Gross, 1937, 1950; Lippert, 1939; Tarlo, 1965). However, the fragmentary material reported here can hardly be attributed to *D. lipperti* which has been based upon disarticulated branchial, postorbital, and median dorsal plates (Gross, 1963, figs 5-6, Pl. 1: 7, Pl. 2: 11, Pl. 6: 6; Tarlo, 1965, fig. 3A). So, we keep it under open nomenclature.

4. Conclusion

This discovery of *Drepanaspis* in the Emsian of Oesling, northern Luxembourg, adds a new geographical record of the genus. As it comes from a locality dated as middle-upper Emsian by its co-occurring miospores, it confirms the occurrence of *Drepanaspis* in the

Emsian of the Neufchâteau-Eifel Synclinorium of the Ardenne Allochthon. It also fills a gap in the Early Devonian faunal assemblage of western Europe because *Drepanaspis*, already well known in the Pragian-Emsian of SW England and western Germany, had not yet been reported from the Ardenne Massif. East of Luxembourg, *Drepanaspis lipperti* has been reported from the Clervaux Formation (Klerf-Schichten, E2) of Zweifelscheid and Willwerath, Germany (Gross, 1937, 1950; Lippert, 1939), together with elements of the head and thoracic carapace of the placoderm "*Phlyctaenaspis*" sp. (in fact an arthrodire Actinolepina?: Blieck *et al.*, 1998), and scales of the sarcopterygian *Porolepis* (Lippert, 1939). The latter genus (specimen E1B125) is also recorded from the Emsian, Schuttbourg Formation of the Consthum "Rinnen" quarry, some 5 km NE of Merkholtz (Fig. 1; this locality is also dated middle/upper Emsian by its miospore content which is very similar to the one of the Merkholtz South-East quarry sample E1B128). This discovery will deserve further study.

Finally, the discovery of *Drepanaspis* and its co-occurring faunal and floral fossils in the Merkholtz South-East quarry points to a problem of regional geology. The sedimentary sequence of this quarry is traditionally attributed to the Schuttbourg Formation, supposed to be early Emsian in age, but its fossil content, including miospores, macroplants, bivalves, pterygotids, ostracodes, and vertebrates, indicates a middle-upper Emsian age.

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