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Taxonomy and biostratigraphy of some proetid trilobites in the Middle Devonian of the Ardennes and Eifel (Rhenohercynian Zone)

by Allart P. VAN VIERSEN & Harald PRESCHER

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Abstract

Proetids are common trilobites in the Middle Devonian of the Ardennes and Eifel. They are known from ample material and so provide an excellent basis for taxonomic and biostratigraphic studies. Seven new species are recorded from the Ardennes, Belgium (*Gerastos arcus* n. sp., *Gerastos couvinensis* n. sp., *Gerastos snellingsi* n. sp., *Astycoryphe exilis* n. sp., *Astycoryphe jorusi* n. sp., *Cornuproetus latentissimus* n. sp., *Dechenella rossumi* n. sp.) and four additional ones from the Eifel, Germany (*Gerastos kippingi* n. sp., *Gerastos batrachus* n. sp., *Gerastos rommersheimensis* n. sp., *Dohmiella acanthonota* n. sp.), on the basis of recent collecting and examination of institutional collections. *Astycoryphe* sp. B, *Cornuproetus* cf. *latentissimus* n. sp. and *Cornuproetus* sp. 2 (Ardennes) are also described. The holotype of *Astycoryphe senckenbergiana* RICHTER & RICHTER (Eifel) is refigured. A preliminary overview of the stratigraphic distributions of species in Eifelian to lowermost Givetian strata in the Ardennes and Eifel is presented, so far encompassing the genera *Gerastos*, *Dohmiella* (Proetinae), *Cornuproetus*, *Diademaproetus* (Cornuproetinae), *Astycoryphe*, *Tropidocoryphe* (Tropidocoryphinae) and *Dechenella* (Dechenellinae).

Keywords: Trilobita, Proetidae, Devonian, Belgium, Germany, France.

Résumé

Les proetidés sont des trilobites communs dans le Dévonien moyen des Ardennes et de l'Eifel. Ils sont connus sur base d'un matériel abondant et forment ainsi une excellente base pour des études taxonomiques et biostratigraphiques. Sept nouvelles espèces sont décrites dans les Ardennes, Belgique (*Gerastos arcus* n. sp., *Gerastos couvinensis* n. sp., *Gerastos snellingsi* n. sp., *Astycoryphe exilis* n. sp., *Astycoryphe jorusi* n. sp., *Cornuproetus latentissimus* n. sp.,

Dechenella rossumi n. sp.) et quatre autres dans l'Eifel, Allemagne (*Gerastos kippingi* n. sp., *Gerastos batrachus* n. sp., *Gerastos rommersheimensis* n. sp., *Dohmiella acanthonota* n. sp.), sur base de fouilles récentes et de l'examen de collections institutionnelles. *Astycoryphe* sp. B, *Cornuproetus* cf. *latentissimus* n. sp. et *Cornuproetus* sp. 2 (Ardennes) sont également décrites. L'holotype de *Astycoryphe senckenbergiana* RICHTER & RICHTER (Eifel) est refiguré. Une synthèse préliminaire de la répartition stratigraphique des espèces dans les strates de l'Eifelien et de la partie basale du Givétien des Ardennes et de l'Eifel est présentée, comprenant à ce jour les genres *Gerastos*, *Dohmiella* (Proetinae), *Cornuproetus*, *Diademaproetus* (Cornuproetinae), *Astycoryphe*, *Tropidocoryphe* (Tropidocoryphinae) et *Dechenella* (Dechenellinae).

Mots-clés: Trilobita, Proetidae, Dévonien, Belgique, Allemagne, France.

Introduction

The Devonian rocks that outcrop in the Ardennes (Belgium, France) and Eifel (Germany) were deposited in an epicontinental sea on the southern margin of the Old Red Continent. Trilobites were already present here in the basal Lochkovian (e.g. ASSELBERGHS, 1946; RICHTER & RICHTER, 1954; GODEFROID *et al.*, 1994; VAN VIERSEN & PRESCHER, 2009) and remained important elements of the benthic biota during most of the Devonian period. Following earlier studies on trilobites from the Ardennes (e.g. MAILLIEUX, 1904, 1919, 1938; RICHTER & RICHTER, 1919) a general consensus has existed that most species are the same as those described from coeval strata in the Eifel. Recent investigations on Devonian outcrops in the Ardennes and Eifel (Fig. 1) have confirmed that there are many similarities between the trilobite assemblages at the genus level but they also indicate that there are regularly intrageneric differences. Even within each region variation can be noteworthy and, not rarely, warrant distinction at the species level. An exemplary

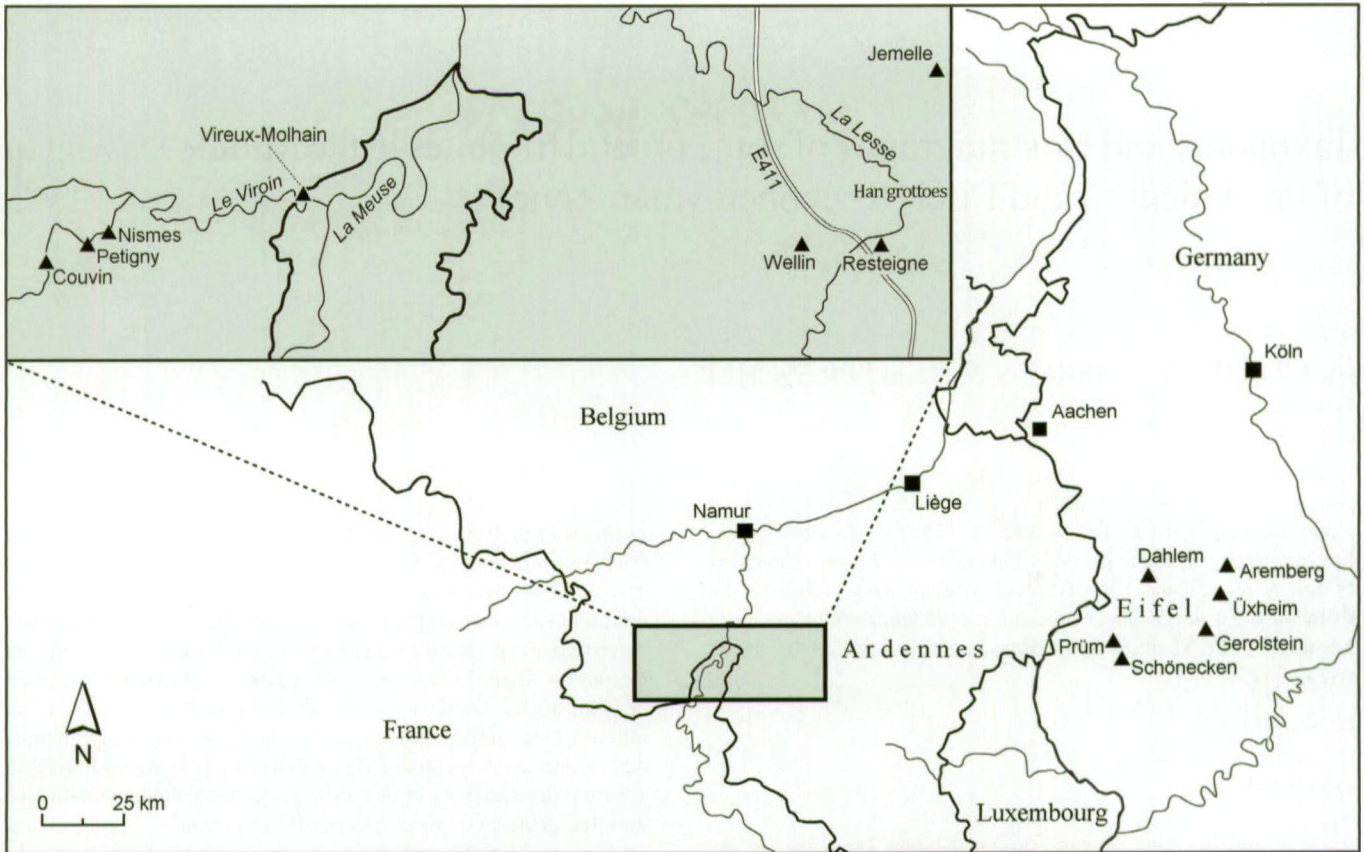


Fig. 1 – Map with indications of trilobite-bearing localities in the Ardennes and Eifel. Generalised positions are given for Prüm (incl. Rommersheim), Üxheim (incl. Ahütte), and Gerolstein (incl. Gees, Pelm and Auburg).

case of this may be provided by Proetidae. Being known from copious material of various geographic and stratigraphic provenances, Proetidae is one of the most ubiquitous trilobite families in Middle Devonian strata in the Ardennes and Eifel. In recent times, LÜTKE (1990) and BASSE (1996, 1997, 2002) greatly enhanced our knowledge of proetid taxonomy in the Eifel, whereas VAN VIERSEN & PRESCHER (2008) laid down a foundation for the Ardennes (southern border of Dinant Synclinorium) where Devonian trilobites had rarely been studied since the 1940s. We report here on additional proetid specimens from both these regions.

Distribution of Proetidae in the Ardennes and Eifel

Emsian–Eifelian transition

Setting aside periodic Lochkovian to Early Emsian occurrences (VAN VIERSEN & PRESCHER, 2009, and references therein) proetids first become recurrent in the Ardennes and Eifel near the Emsian–Eifelian (Lower–Middle Devonian) boundary.

In the Eifel, *Gerastos*, *Basidechenella* and *Sculptoproetus* appear in the uppermost Emsian

(BASSE, 2002). Of these genera only *Basidechenella* does not cross the boundary between the Heisdorf and Lauch Formations (STRUVE & WERNER, 1982), i.e., it disappears just above the Emsian–Eifelian boundary which is located in the upper part of the Heisdorf Formation. *Gerastos* and *Sculptoproetus* are known from few, isolated occurrences alone. During the lower Eifelian, *Astycoryphe*, *Tropidocoryphe*, *Lauchellum* and *Dohmiella* are introduced, these last two genera being the only innovations. *Sculptoproetus* (uppermost Emsian to lowermost Eifelian) and *Lauchellum* (lowermost Eifelian) demonstrate short stratigraphic extents but they are not known from the Ardennes; no new data are available for the Eifel in addition to BASSE (2002).

In the Ardennes, *Gerastos*, *Dohmiella*, *Astycoryphe*, *Tropidocoryphe* and *Diademaproetus?* appear in the basal Eifelian. There are no verified records of Proetidae from close to the Emsian–Eifelian boundary, except for records of imprecise origin of *Basidechenella* sp. and *Lauchellum?* sp. (BASSE & MÜLLER, 2004) and, possibly, an occurrence of *Gerastos* in Upper Emsian strata in Couvin (VAN VIERSEN & PRESCHER, 2009).

Eifelian–Givetian transition

Astycoryphe, *Gerastos*, *Dohmiella* and *Cornuproetus* continue until the uppermost Eifelian in both regions, whereas *Diademaproetus* (only Eifel) and *Tropidocoryphe* disappear here in the middle Eifelian. *Gerastos prox* (RICHTER & RICHTER, 1956) and morphologically similar species are typically found in strata of late Eifelian to earliest Givetian age.

In the Eifel, the Eifelian–Givetian boundary seems to be roughly definable by use of proetid distributions. *Dohmiella* is decimated in the uppermost Eifelian and is currently known in the (lowermost) Givetian only from *Dohmiella* cf. *bacchus* of BASSE (2002). Likewise, *Gerastos prox* comes from around the boundary (BASSE, 2002). According to CHLUPÁČ *et al.* (2000) *Cornuproetus* generally does not carry on in the Givetian but FEIST & ORTH (2000) and BASSE (2002) described representatives from the basal Givetian in Morocco and Germany, respectively.

In the Ardennes, the Eifelian–Givetian boundary is located in the Hanonet Formation which marks the transition from the shales and siltstones of the lowerlying Jemelle Formation to the first Givetian reef complex. This setting is interpreted as a middle ramp in our Couvin and Resteigne localities and the development of a local reef lense in Wellin (BOULVAIN *et al.*, 2009, and references therein). *Astycoryphe*, *Dohmiella* and *Cornuproetus* all seem to disappear at the end of the Eifelian although it should be stressed that upper Eifelian strata were sampled more by us than Lower Givetian strata. So far, we encountered *Dechenella* in the Givetian part of the Hanonet Formation in most of the investigated localities along the southern border of the Dinant Synclinorium, whereas but a single *Gerastos* specimen is known of this age (*Gerastos snellingsi* n. sp. from the Wellin reef). *Dechenella* and *Gerastos* are the only proetids that are known to persist into the overlying Trois-Fontaines Formation (VAN VIERSEN, 2007).

Correlations between the Ardennes and Eifel

When considering the proetids that are known from both the Ardennes and Eifel at present (see below), only few seem to be potentially informative for high-resolution interregional stratigraphic correlations. Most genera either range throughout the Eifelian and beyond (e.g. *Gerastos*) or they are currently known from only one of these regions (e.g. *Sculptoproetus*). Further complicating are the imprecise origins of some specimens in old museum collections and a substantial lack of proetid material from parts of the Middle Devonian in both regions (e.g. the upper *costatus* and lower *kockelianus*

conodont zones) for which there is no straightforward explanation. Data on the Emsian–Eifelian transition in (especially) the Ardennes are still scant so that there is currently little potential for interregional correlations there. However, it seems possible to roughly pinpoint the Eifelian–Givetian boundary in both regions which corresponds approximately to the disappearance of *Dohmiella* and *Astycoryphe* together with (Ardennes) or followed shortly by (Eifel) *Cornuproetus*. *Dohmiella* is furthermore last observed at around the Eifelian–Givetian transition in Moravia (CHLUPÁČ, 1992) and the Holy Cross Mountains (KIELAN, 1954), but the exact age of these records is difficult to resolve based on currently available data.

Dechenella has been considered an indicator of the upper Eifelian (*ensensis* conodont Zone) to Givetian in parts of the Rhenish Mountains (see, e.g. BASSE, 2000a). The discovery of an isolated occurrence in the Jemelle Formation in Jemelle (BLONDIEAU, 1995; VAN VIERSEN, 2007) indicates that in the Ardennes, this genus probably already occurs in the middle Eifelian. Among few proetid-based biozonations for the Ardenno-Rhenish Mountains published is that proposed by STRUVE (1996a) in which the transition between *Dechenella praeverneuili* STRUVE, 1992 and *Dechenella verneuili* (BARRANDE, 1852) corresponds more or less to the *kockelianus*–*hemiansatus* boundary. This zonation is notional given that *D. praeverneuili* is considered to be known only from inadequately preserved specimens (BASSE, 2002). Furthermore, the holotype of *D. praeverneuili*, which was collected from loose rocks on an agricultural field, is likely to have come from the lower part of the Freilingen Formation (field observations by HP; see BASSE, 2002, p. 31 for additional remarks) while according to BASSE (2002), *D. verneuili* is restricted to the transition between the Loogh and Cürten Formations, thus significantly higher than assumed by STRUVE (1996a). This means that there is a substantial gap between known stratigraphic ranges of these species.

BASSE (2002) recorded a new subspecies *Quadratoproetus quadratus weberi* from the Eifel and noticed that this genus is otherwise only known from the deeper waters of the “Hercynian” facies. This author added that its occurrence in the Freilingen Formation coincides with an eustatic sea level rise attributed to the Kačák – *otomari* Event and that the two may be related. We have material in our possession of a species of *Quadratoproetus* from coeval strata in the Couvin area which will be described in a future publication.

List of taxa

Selected species of proetid genera currently known from both the Ardennes and Eifel are listed below and depicted in Fig. 2. Data for (especially) the Ardennes are preliminary and it should be stressed that the given distributions are maximum ranges which may be reduced or extended in the future.

Ardennes (Belgium, northern France)

Gerastos catervus (VAN VIERSEN, 2006a), Jemelle Formation, Vireux-Molhain.

Gerastos arcus n. sp., Jemelle Formation, Petigny.

Gerastos sp. B of VAN VIERSEN & PRESCHER (2008), ?Jemelle Formation, Resteigne area.

Gerastos dhondtae MAGREAN, 2007 (*nom. corr.*, VAN VIERSEN *et al.*, 2009), Jemelle Formation, Petigny.

Gerastos couvinensis n. sp., Hanonet Formation, Couvin.

Gerastos lessensis VAN VIERSEN & PRESCHER, 2008, Hanonet Formation, Resteigne.

Gerastos snellingsi n. sp., Hanonet Formation, Wellin.

Dohmiella dewildei VAN VIERSEN, 2006b, Couvin Formation, Nismes.

Dohmiella sp. I of VAN VIERSEN (2006b), Jemelle Formation, Jemelle.

Dohmiella tenuiornata VAN VIERSEN & PRESCHER, 2008, Hanonet Formation, Resteigne.

Diademaproetus? sp. of VAN VIERSEN & PRESCHER, 2008, Jemelle Formation, Vireux-Molhain.

Cornuproetus sp. 2, Jemelle Formation, Jemelle.

Cornuproetus sp. 2? (= *Cornuproetus cornutus cornutus* of MAGREAN, 2007), Jemelle Formation, Couvin.

Cornuproetus sp. 3 (AVV and HP, unpubl. data), Hanonet Formation, Olloy-sur-Viroin.

Cornuproetus latentissimus n. sp., Hanonet Formation (see Systematic Palaeontology section for doubtful Lower Givetian occurrence indicated by an interrupted line), Couvin.

Cornuproetus cf. *latentissimus* n. sp., Hanonet Formation, Resteigne.

Astycoryphe sp. B, Couvin Formation, Nismes.

Astycoryphe cf. *senckenbergiana* (= *Astycoryphe senckenbergiana* of MAGREAN, 2006), Jemelle Formation, Jemelle.

Astycoryphe exilis n. sp., Hanonet Formation, Couvin.

Astycoryphe jorusi n. sp., Hanonet Formation, Resteigne.

Tropidocoryphe sp. N (AVV and HP, unpubl. data), Couvin Formation, Nismes.

Tropidocoryphe barroisi (MAILLIEUX, 1904), Jemelle Formation, Couvin [coeval specimens from the Jemelle Formation in Jemelle and Hotton recorded by MAGREAN (2006) and VAN VIERSEN *et al.* (2009) respectively, are possibly conspecific].

Dechenella daumeriesi VAN VIERSEN & PRESCHER, 2008, Hanonet Formation, Resteigne.

Dechenella rossumi n. sp., Hanonet Formation, Resteigne.

Eifel (based on data from BASSE, 2002 and modified after field observations by HP)

Gerastos wetteldorfensis (BASSE, 2002), Heisdorf Formation, Schönecken.

Gerastos sp. n. S of BASSE (1998), Heisdorf Formation, Üxheim.

Gerastos cultrijugati (RICHTER & RICHTER, 1918), Lauch Formation, Gees.

Gerastos kippingi n. sp., Nohn Formation, Üxheim.

Gerastos sp. A of VAN VIERSEN & PRESCHER, 2008, Ahrdorf Formation, Lissingen.

Gerastos granulatus GOLDFUSS, 1843, Ahrdorf Formation, Gees.

Gerastos cuvieri (STEININGER, 1831), Ahrdorf Formation, Gees.

Gerastos batrachus n. sp., Freilingen Formation, Rommersheim.

Gerastos rommersheimensis n. sp., Freilingen Formation, Rommersheim.

Gerastos prox (RICHTER & RICHTER, 1956), Ahabach Formation, Ahütte.

Gerastos eifliensis BASSE, 2002, Cürten Formation, Üxheim.

Dohmiella sp. A of BASSE (2002), ?Lauch Formation, Dausfeld.

Dohmiella prescheri VAN VIERSEN, 2006b, Nohn Formation, Üxheim.

Dohmiella stumporum VAN VIERSEN & PRESCHER, 2008, Ahrdorf Formation, Lissingen.

Dohmiella acanthonota n. sp., Ahrdorf Formation, Gerolstein.

Dohmiella chamaeleo (RICHTER & RICHTER, 1918), Ahrdorf Formation, Gees.

Dohmiella dohmi (RICHTER & RICHTER, 1918), Junkerberg Formation, Auburg.

Dohmiella bacchus BASSE, 2002, Freilingen Formation, Üxheim.

Dohmiella cf. *bacchus* of BASSE (2002), Ahabach Formation, Üxheim.

Diademaproetus menzeni KOWALSKI, 1975, Ahrdorf Formation, Gees.

Cornuproetus cornutus (GOLDFUSS, 1843), Ahrdorf Formation, Gees.

Cornuproetus rhenanus (BASSE, 2002), Ahrdorf Formation, Gees.

Cornuproetus pruemensis BASSE, 2002, Freilingen Formation, Rommersheim.

Cornuproetus cf. *meinkenbrachtenensis* of BASSE (2002), Ahabach Formation, Üxheim.

Astycoryphe spp. (= *Astycoryphe senckenbergiana* of BASSE, 2002, *pro parte*), Nohn/Ahrdorf/Junkerberg Formations, various localities.

Astycoryphe senckenbergiana RICHTER & RICHTER, 1919, Ahrdorf Formation, Gees.

Astycoryphe sp. A of BASSE (2002), Ahabach Formation, Rommersheim.

Tropidocoryphe sp. H of BASSE (2002), Lauch or Nohn

	Devonian stages		Eifelian					Givetian
	patulus	partitus	costatus	australis	hockelanus	hemiansatus		
New ↓	Formations on the southern border of the Dinant Synclinorium		Jemelle Fm					Hanonet Fm
	Eau Noire Fm		Couvign Fm					
Trilobites (Ardennes)								
x	Gerastos catervus							
	Gerastos arcus							
	Gerastos sp. B							
	Gerastos dhondtae							
x	Gerastos couvignensis							
	Gerastos lessensis							
x	Gerastos snellingsi							
	Dohmiella dewildei							
	Dohmiella sp. 1							
	Dohmiella tenuicornata							
	Diademaproetus? sp.							
	Cornuproetus sp. 2							
	Cornuproetus sp. 2?							
x	Cornuproetus sp. 3							
	Cornuproetus latentissimus							
x	Cornuproetus cf. latentissimus							
x	Astycoryphe sp. B							
	Astycoryphe cf. senckenbergiana							
x	Astycoryphe exilis							
x	Astycoryphe jorusi							
x	Tropidocoryphe sp. N							
	Tropidocoryphe barroisi							
	Dechenella daumenesi							
x	Dechenella rossumi							
Formations in the Eifel								
Haisdorf Fm Lauch Fm Nohn Fm Ahrdorf Fm Junkenberg Fm Freilingen Fm Ahrbach Fm Loog Fm								
Trilobites (Eifel)								
	Gerastos wettedorfensis							
	Gerastos sp. n. S							
x	Gerastos cultrijugati							
	Gerastos kippingi							
	Gerastos sp. A							
	Gerastos granulatus							
	Gerastos cuvieri							
x	Gerastos batrachus							
x	Gerastos rommersheimensis							
	Gerastos prox							
	Gerastos eiffliensis							
	Dohmiella sp. A							
	Dohmiella prescheri							
	Dohmiella stumporum							
x	Dohmiella acanthonota							
	Dohmiella chamaeleo							
	Dohmiella dohmi							
	Dohmiella bacchus							
	Dohmiella cf. bacchus							
	Diademaproetus menzeni							
	Cornuproetus cornutus							
	Cornuproetus rhenanus							
	Cornuproetus pruemensis							
	Cornuproetus cf. meinkenbrachtenensis							
	Astycoryphe spp.							
	Astycoryphe senckenbergiana							
	Astycoryphe sp. A							
	Tropidocoryphe sp. H							
	Tropidocoryphe sp. D							
	Tropidocoryphe bassei							
	Tropidocoryphe aff. endorfensis							
	Dechenella praevermeuili							
	Dechenella walsdorfensis							
	Dechenella uexheimensis							
	Dechenella wotanica							
	Dechenella vermeuili							
	Dechenella ardennorhenana							

Fig. 2 – Estimated maximum stratigraphic ranges of selected Proetidae in the uppermost Emsian to lowermost Givetian of the Ardennes (above) and Eifel (below). Lower and upper boundaries of respectively the oldest and youngest stratigraphic units are pretermitted (for instance, the lower boundaries of the Eau Noire Formation and *patulus* conodont Zone do not really coincide). Formations in the Ardennes (southern border of Dinant Synclinorium) were based on BULTYNCK & COEN-AUBERT (2000); formations in the Eifel are according to STRUVE (1996b). First column on the left indicates previously unrecorded taxa.

Formation, Gees.

Tropidocoryphe sp. D (= *Tropidocoryphe barroisi* of MAGREAN, 2006, *pro parte*), Nohn Formation, Üxheim.

Tropidocoryphe bassei VAN VIERSEN *et al.*, 2009, Ahrdorf Formation, Gees.

Tropidocoryphe aff. *endorfensis* of BASSE (2002), Junkerberg Formation, Auburg.

Dechenella praeverneuili STRUVE, 1992, Freilingen Formation, Aremberg.

Dechenella walsdorffensis BASSE, 2002, Loogh Formation, Üxheim.

Dechenella uexheimensis BASSE, 2002, Loogh Formation, Üxheim.

Dechenella wotanica BASSE, 2002, Loogh Formation, Üxheim.

Dechenella verneuili (BARRANDE, 1852), Loogh or Cürten Formation, Pelm.

Dechenella ardennorhenana BASSE, 2002, Loogh or Cürten Formation, Dahlem.

Locations and stratigraphy

Ardennes, southern border of Dinant Synclinorium (Belgium)

Loc002, "Carrière de la Lesse", Resteigne.

Abandoned quarry just north of the village of Resteigne described by COEN-AUBERT *et al.* (1986). Coordinates are N50°05.400', E5°10.650'. Lists of trilobite species and associated macrofaunal elements in the lower part of the Hanonet Formation (upper Eifelian) were given by VAN VIERSEN (2007) and VAN VIERSEN & PRESCHER (2008). Specimens assigned here to *Astycoryphe jorusi* n. sp. and *Cornuproetus* cf. *latentissimus* n. sp. were collected from the lower part of the Hanonet Formation and are of a latest Eifelian age. *Dechenella rossumi* n. sp. comes from the upper (Lower Givetian) part of this same formation.

Loc004, embankment south of the railway station, Jemelle.

Outcrop just south of the Jemelle railway station (N50°09.420', E5°15.880') described and indicated on a map by MAGREAN & VAN VIERSEN (2005). VAN VIERSEN & PRESCHER (2008) provided a comprehensive species list of the rich trilobite biota (> 20 species). Specimens were collected from the Chavées Member of the Jemelle Formation (middle Eifelian).

Loc006a, "Fond des Vaux West" quarry, Wellin.

Active quarry just north of the village of Wellin described by COEN-AUBERT *et al.* (1991), among others. Coordinates are N50°05.700', E5°06.900'. The holotype of *Gerastos snellingsi* n. sp. was collected by

Jules Snellings in the late 1980s from a Lower Givetian horizon in the Hanonet Formation, within a range that corresponds to the upper Ahabach to basal Loogh Formation in the Eifel. Numerous macrofaunal elements were recovered by Snellings from the same horizon (det. HP): *Halocrinites schlotheimii* STEININGER (revised generic assignment follows BOHATÝ & HERBIG, in press), *Calceola sandalina* (LINNAEUS) ssp. ("slender form") and brachiopods including *Pentamerella davidsoni* (SCHNUR), *Desquamatia* sp., *Cyrtina heteroclita* (DEFRANCE) ssp., *Artrythyris* sp., *Atryparia* cf. *dispersa* (STRUVE), *Glyptogypa* cf. *multiplicata* (C.F. ROEMER). A specimen of each of these brachiopod taxa is deposited in the Natuurhistorisch Museum Maastricht (NHMM 2009089). The *Calceola* specimens from this locality will be described elsewhere (WRIGHT *et al.*, in press).

VAN VIERSEN & PRESCHER (2008) recorded a pygidium designated *Dechenella* sp. A from Wellin which they incorrectly referred to the nearby "Les Limites" quarry. Their specimen actually came from a higher (Lower Givetian) horizon in the "Fond des Vaux West" quarry (pers. comm. with Snellings).

Loc021, "La Couvinoise" quarry, Couvin.

Active quarry on the northern outskirts of Couvin which has previously been called "Carrière Haine" and "Carrière Collard et Guillaume" (N50°03.580', E4°29.350'). The reader is referred to VAN VIERSEN (2007) and papers named therein for details on this locality and its trilobites. All of the recorded specimens come from the lower part of the Hanonet Formation and are of a late Eifelian age.

Loc028, abandoned quarry, Nismes.

Quarry on the western outskirts of Nismes (N50°03.720', E4°32.600'). A description of this locality and its trilobites which came from the Foulerie Member of the Couvin Formation (lower Eifelian) was provided by VAN VIERSEN (2006b) and VAN VIERSEN & DE WILDE (2010). Two librigenae identified as *Astycoryphe* sp. B are described in the present note. We also recovered specimens which will be described by us in a future publication and which are designated *Tropidocoryphe* sp. N for now.

Loc050 "Champs des trilobites", Petigny.

During examination of the old Maillieux collections in the IRSNB in 2008 we came across several *Gerastos* specimens which, according to their label, were collected from the "Couviniens Co2c, Champs des trilobites, Pl. Couvin 11a, Petigny". This locality corresponds to a

pasture just west of Petigny (N50°03.315', E4°31.460'), indicated by Maillieux on his field maps which are kept by the IRSNB. Between Couvin and Givet, the upper part of the Gemelle Formation overlies the biostromal Couvin Formation (BULTYNCK & DEJONGHE, 2001). At the geographic position indicated by Maillieux on his maps the Gemelle Formation outcrops which directly overlies the Couvin Formation here. The presumed age of the specimens corresponds roughly to the transition between the *costatus* and *australis* conodont zones.

Eifel

Üxheim01

Southern slope of Kirberg Hill, about 500 m north northeast of the church of Üxheim, Hillesheim Syncline. Coordinates are r 5433 / h 7912, according to ERBEN (1953, p. 77). Trilobites were collected from the Kirberg Member of the Nohn Formation (lower Eifelian). For a comprehensive list of trilobites, see VAN VIERSEN & DE WILDE (2010).

Gerolstein02

Temporary drainage ditch on the edge of the wood near holiday park Gerolstein, at about 1000 m west from the Munterley rock, Gerolstein Syncline. See topographic map, sheet 5705 Gerolstein, r (25)45810 / h (55)65951. Specimens of *Dohmiella acanthonota* n. sp. were recovered from the Köll Member of the Ahrdorf Formation (middle Eifelian).

Rommersheim01

Slope of the former highway E42 at about 800 m south of Brunnen Brühlborn, Prüm Syncline. See topographic map, sheet 5704 Prüm, r (25)32925 / h (55)63575. Trilobite specimens were collected from the Eilenberg Member of the Freilingen Formation (upper Eifelian). This site is the same as BASSE's (2002) "Prüm 1b", the type locality and horizon of *Cornuproetus pruemensis*.

Systematic palaeontology

The following prefixes are used for type numbers of specimens: IRSNB (Institut royal des Sciences naturelles de Belgique); NHMM (Naturhistorisch Museum Maastricht); SMF (Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main). All figured specimens were coated with ammonium chloride sublimate prior to photography. Morphological terminology essentially follows that of WHITTINGTON & KELLY (1997).

Family Proetidae SALTER, 1864

Discussion

The classification of subfamilies included in Proetidae is currently under debate (see, e.g. CHATTERTON *et al.*, 2006). We opted for a suprageneric classification as it is commonly used in the recent literature, with the exception of Tropidocoryphidae. We are not convinced that the morphology of taxa included in this group warrants distinction at the family level and therefore prefer to place these in Proetidae, at least for the time being.

Subfamily Proetinae SALTER, 1864

Genus *Gerastos* GOLDFUSS, 1843

Type species: Proetus cuvieri STEININGER, 1831 from the Eifelian of the Eifel.

Discussion

Members of this genus are stratigraphically and geographically widely distributed. They occur in various types of sediments in Germany, Belgium, Poland, Czech Republic and Morocco, among other countries, which demonstrates their ability to adapt to different environments. In the Ardennes and Eifel *Gerastos* ranges from the Upper Emsian to the Lower Givetian (Fig. 2) but it is not as common here as in Morocco where specimens abound in strata of Emsian to Givetian age (field observations by HP). VAN VIERSEN & PRESCHER (2008) already noticed that another proetine, *Dohmiella*, which has long been known in the Ardennes and Eifel from just a handful of specimens, is much more widespread here than had been expected. During fieldwork we encountered regular co-occurrences of *Dohmiella* and *Gerastos* but the ratios of individuals of these genera are always exceedingly unbalanced. *Dohmiella* is the dominant proetine in a number of investigated outcrops of early to middle Eifelian age (e.g. type localities of *Dohmiella prescheri*/*Gerastos kippingi* n. sp.; *Dohmiella stumporum*/*Gerastos* sp. A of VAN VIERSEN & PRESCHER, 2008) and remains the solely discovered proetine in others (e.g. type localities of *Dohmiella dewildei*; *Dohmiella acanthonota* n. sp.). The abundance of *Gerastos cuvieri* at the "Trilobitenfelder" compared to rare *Dohmiella chamaeleo*, attests to the contrary in other places. During the upper Eifelian, members of *Gerastos* are generally much commoner than *Dohmiella*.

A genus which has been revised and incorporated in *Gerastos* more than once is *Longiproetus* (see,

e.g. OWENS, 1973; ŠNAJDR, 1980; LÜTKE, 1990). BASSE (1996, 2002) restricted *Longiproetus* to taxa from middle Eifelian to Lower Givetian strata in the Rhenish Mountains that are similar to the type species, *L. tenuimargo* (RICHTER, 1909), while referring to LÜTKE (1990) for a generic diagnosis. When reviewing the characters provided by LÜTKE, none are really adequate to distinguish *Longiproetus* from *Gerastos* except, maybe, for the flat-topped or concave anterior border and the distinctly divergent preocular sutures (γ - β). We agree with BASSE (2002) that his specimens are best assigned to *Longiproetus* should that genus be retained but the scant published material makes it difficult to either accept or reject it at this time. To our knowledge, *Longiproetus* has not been recorded in the Ardennes.

Based on the currently available data it appears that *Gerastos* exhibits several morphologic trends in the Middle Devonian of the Ardennes and Eifel. As interpreted herein it includes taxa formerly assigned to *Rhenocynproetus* which are dominant in the lower Eifelian, *Gerastos cuvieri* and similar taxa which occur roughly in the middle Eifelian, and species similar to *Gerastos prox* which commence in the upper Eifelian (Fig. 3). Although it may seem appealing to group these members of *Gerastos* based upon generally similar morphology and age, there is little doubt that this would lead to artificial taxa. The problem with recognising one such group was already addressed by VAN VIERSEN & PRESCHER (2008), who placed *Rhenocynproetus* in synonymy of *Gerastos*, because they believed that it (1) was based largely on plesiomorphic characters and (2) included species that were intermediate with *Gerastos*. The descriptions of *Gerastos couvinensis* n. sp. and *Gerastos rommersheimensis* n. sp. herein raise questions as to where to set the boundaries of *Gerastos prox*, with which they both share many resemblances. Various *Gerastos* specimens have been assigned to *G. prox* (usually proposed as subspecies) by different workers in a comparatively short amount of time (e.g. ALBERTI, 1969; LIEBERMAN, 1994; BASSE, 1996, 2000a, 2000b, 2002; FEIST & ORTH, 2000; MAGREAN, 2007; VAN VIERSEN, 2007; VAN VIERSEN & PRESCHER, 2008) whereas BASSE (2002) transferred a number of specimens from RICHTER & RICHTER'S (1956) type series to *Gerastos eifliensis*. Considering the increasing amount of taxa that are more or less similar to *G. prox* we deliberately treat all as distinct species until their phylogenetic relationships are worked out, something that is beyond the scope of the present work. The same goes for subspecies of *Cornuproetus cornutus* discussed below.

According to ADRAIN (1997) prominent rows of pores around the margins of the cephalic and pygidial borders are a potentially robust apomorphy of *Gerastos*. CHATTERTON *et al.* (2006) stated that they did not discover these pores on any of the Devonian species from Morocco or Europe that they would assign to this genus and that this feature appears to be restricted to a group of Laurentian Silurian species. We observed pores on specimens described here as *Gerastos kippingi* n. sp. (Fig. 4; see below) and on an undocumented species from the Ardennes that will be described by us at a later time. We also corroborate their presence on well-preserved, topo- and stratotypical specimens of *Gerastos cuvieri*, the type species of this genus. However, there are at least three examples of this feature in proetids of which we have examined the original material, that are clearly not congeneric. These are *Dechenella daumeriesi* (VAN VIERSEN & PRESCHER, 2008, pl. 5, figs 1-3, 8-11), *Dechenella rossumi* n. sp. (Figs 5A, 5B) and *Basidechenella kayseri* (RICHTER, 1909) (we have new specimens of this last species in our possession which will be described elsewhere). Possibly, pores are also present on *Dohmiella stumporum* which shows small depressions between the terrace lines on the anterior cranial border (Fig. 5C). We have not yet detected the feature on the numerous specimens of *Dohmiella prescheri* that we recovered from the same banks as *G. kippingi* n. sp. in Üxheim (and thus which may be expected to demonstrate comparable preservation). Like CHATTERTON *et al.* (2006) we were also unable to discover them on profuse, well-preserved *Gerastos* specimens of various undescribed species that were collected by one of us (HP) from Devonian strata in Morocco. However, even if preservation can be ruled out as a factor in some if not many cases, ADRAIN (1997) already stated that the apparent absence of this feature can also be due to secondary loss, which does not pertain to its significance. A comprehensive analysis may indicate that the marginal pore rows are a synapomorphy of a larger Siluro-Devonian group of proetid species not exclusive to *Gerastos* but for now their use as an apomorphy of this last genus seems uncertain.

Gerastos kippingi n. sp.

(Fig. 4; Pl. 1, Figs 1-20)

2006 — *Gerastos* sp. aff. *Gerastos cuvieri* (STEININGER) – BASSE, p. 24.

Derivation of name

Named after Michael Kipping (Weiterstadt), friend and fellow trilobite enthusiast.

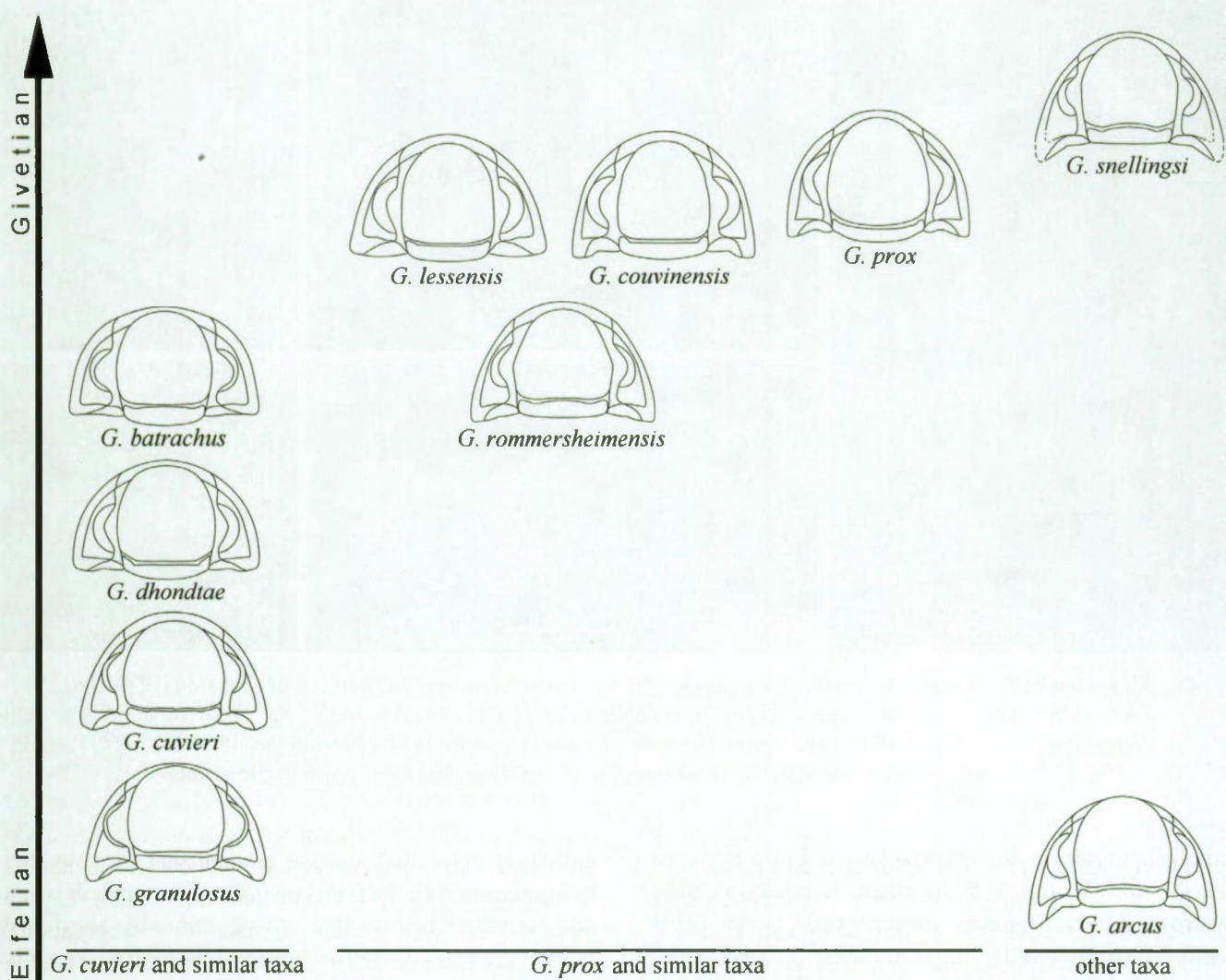


Fig. 3 – Relative stratigraphic occurrences of *Gerastos cuvieri* (STEININGER, 1831) and *Gerastos prox* (RICHTER & RICHTER, 1956) and similar taxa, *Gerastos arcus* n. sp. and *Gerastos snellingsi* n. sp.

Holotype

Cranidium IRSNB a12742 (Pl. 1, Figs 1, 2, 6).

Type locality

Üxheim (Üxheim01), Germany.

Type horizon

Kirberg Member of Nohn Formation.

Paratypes

Two cephalae (IRSNB a12736, a12737), one cranidium (IRSNB a12741), two librigenae (IRSNB a12739, a12743), three pygidia (IRSNB a12735, a12738, a12740); all from type locality and horizon.

Diagnosis

Anterior border of cephalon is very weakly vaulted in front of glabella. Preocular sutures diverge slightly

from β to γ . Furrow between posteriormost pygidial ring and terminal axial piece is broad (sag., exsag.) adaxially. Pygidial border is exceedingly narrow (tr.) anterolaterally, broad (sag., exsag.) posteromedially.

Description

Cephalon is weakly vaulted; its contour is widely subsemicircular. Anterior border of cranidium protrudes slightly from cephalic outline. Anterior to lateral cephalic borders run subhorizontally. Four, moderately distinct terrace ridges are visible dorsally on anterior border. Border furrow of cephalon is narrow, especially shallow on librigenae. Sagittal length of cephalon is 0.54 relative to maximum width of cephalon. Sagittal length of glabella anterior to S0 is 1.0 relative to maximum width of glabella and 0.85 relative to length of cephalon (sag.). Maximum width of glabella is 0.46 relative to maximum width of cephalon. Outline of

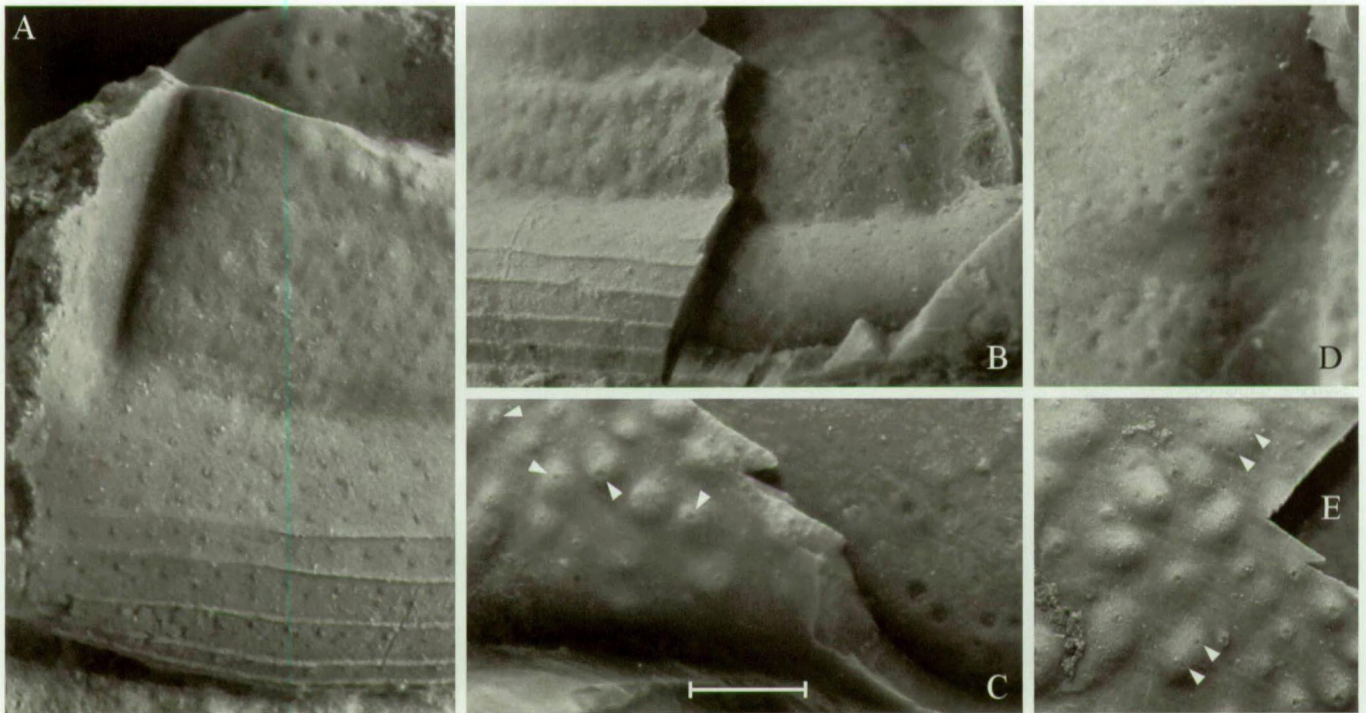


Fig. 4 – Close-ups of the dorsal cuticle of *Gerastos kippingi* n. sp.: lateral view of right librigena of cephalon (IRSNB a12737) (A), lateral view of left librigena of cephalon (IRSNB a12736) (B), dorsal views of right posterolateral (C), right lateral [cuticle is exfoliated] (D) and central (E) parts of glabella anterior to S0 of cranidium (IRSNB a12741) [see Pl. 1, Fig. 13 for overview]. Arrows show the positions of pores on tubercles. Scale bar indicates 1 mm.

glabella anterior to S0 is broadly parabolic between anterior margin and δ , from where it tapers steadily towards S0. Axial furrows are uniformly broad. S0 is faintly W-shaped, indenting somewhat posteromedial margin of glabella anterior to S0. Width of occipital ring is 0.91 relative to maximum width of glabella. Occipital ring does not gain height posteriorly, bearing randomly scattered granules on anterior half and a small median tubercle posteriorly. Lateral occipital lobes are moderately strongly inflated, abaxially fused with occipital ring. S1 runs transversally inward, flexes obliquely downward from where it gradually narrows; S2 faintly curves inward and downward; S3 is a moderately weakly impressed short horizontal line. Postocular sutures converge slightly posteriorly from ϵ , are abruptly posterolaterally flexed near posterior border furrow from where they run obliquely towards far abaxially positioned ω . Librigenal field is moderately steep, and weakly vaulted (tr.). Eye is moderately large. Eye socle is weakly defined. Subocular groove broadens gradually backwards. Subocular ridge is narrow but distinct anteriorly, increasingly weakly developed towards posterior, and bears closely spaced granules that verge to forming a single row. Surface of librigenal field abaxial to subocular ridge bears numerous shallow pits (these are also developed as pits where the

cuticle is exfoliated and we assume that they are not homologous with the pores on parts of the cephalon that are discussed below) that are occasionally alternated by fine granules. Posterior border runs subtransversally to slightly posterolaterally. Genal angle is rounded; a genal thorn or spine is not present.

Pygidium is weakly vaulted (sag., tr.); border furrows are undeveloped. Contour is rounded subtrapezoidal. Sagittal length (including preannulus) of pygidium is 0.59 relative to maximum width. Length (sag.) of axis is 0.85 relative to sagittal length of pygidium. Maximum width of axis is 0.85 relative to sagittal length of axis, and 0.43 relative to maximum width of pygidium. Pygidial border gently downward sloped along with pleural fields without the two being separated by a border furrow. One distinct terrace ridge is present anterolaterally to laterally on pygidial border; posterolaterally another terrace ridge is added; posteromedially one or two additional ones are developed. Axis tapers proportionally backwards until fifth ring; from there narrows more strongly towards posterior. Seven axial rings plus short (sag.) terminal axial piece are present. Axial rings run transversally outward; then flex posterolaterally. Lateral axial lobes are fused except where well-developed apodemes are present; these apodemes are absent on the first ring,

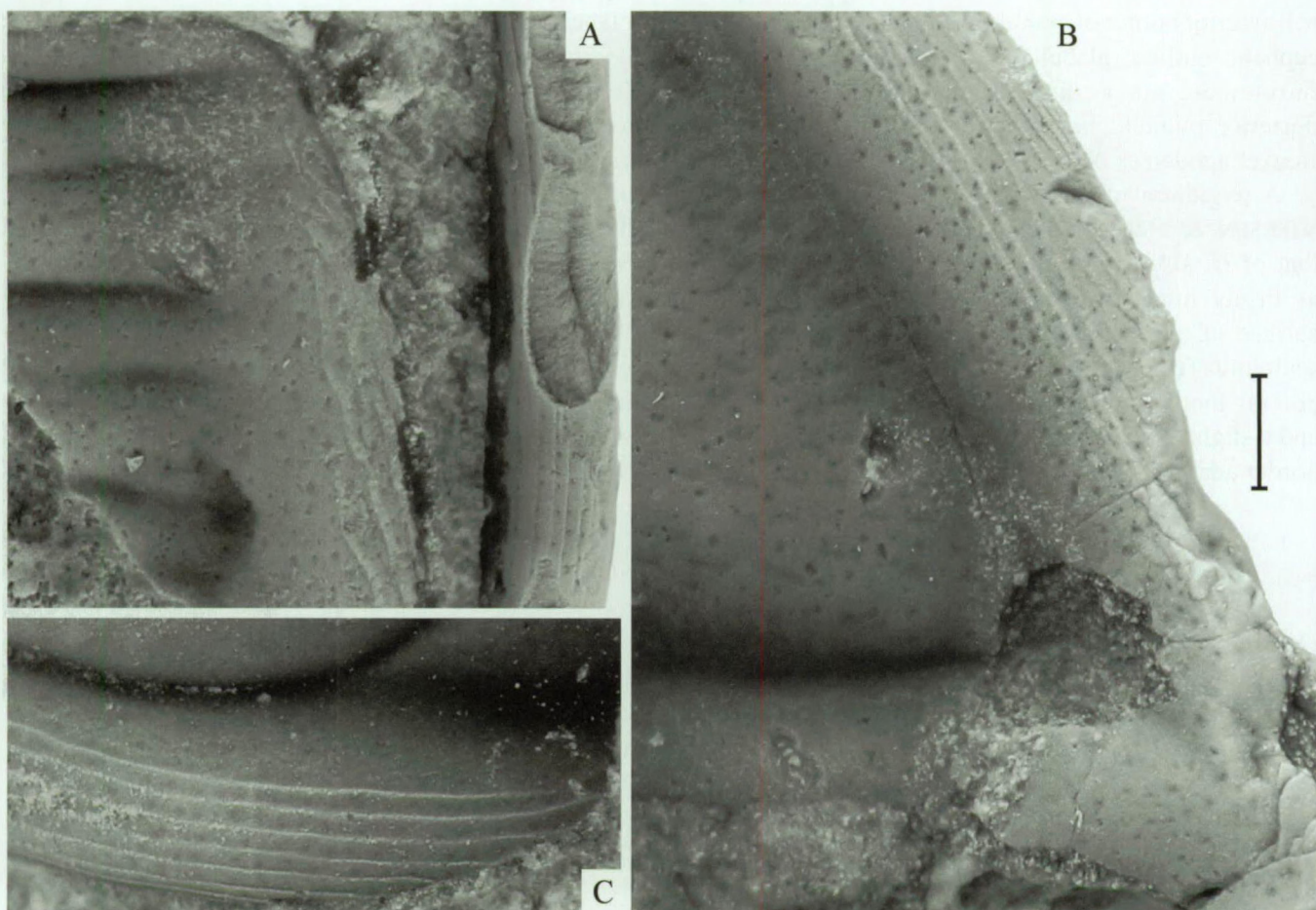


Fig. 5 – Close-ups of the holotype of *Dechenella rossumi* n. sp. (IRSNB a12777): dorsal view of right anterolateral part of pygidium with ventral view of right librigenal border [see Pl. 11, Fig. 8 for overview] (A) and dorsal view of right genal angle (B). Strato- and topotypical, incomplete cranidium of *Dohmiella stumporum* VAN VIERSEN & PRESCHER, 2008 (IRSNB a12785) in oblique anterior view (C). Scale bar indicates 1 mm.

developed as narrow (tr.) impressions located centrally (exsag.) on the second ring, larger and increasingly posteriorly (exsag.) positioned on the subsequent rings. Pleural fields with six pairs of smoothly posterolaterally curved pleurae; a seventh, rudimentary pair may be developed. Pleural furrows more deeply incised than interpleural furrows. Entire pygidium bears few, randomly scattered granules.

Discussion

An interesting feature of *Gerastos kippingi* n. sp. is the presence of pores on parts of the dorsal cuticle. As far as preservation of the studied material allowed it, they are discernible between the terrace lines all over the lateral librigenal border (Fig. 4A) and on its inner part where the cuticle is exfoliated (Fig. 4B). Pores are furthermore present on the smooth surface of LA where they are scarce (or more rarely preserved). Between LA and S0 a single pore is apparent on each tubercle (Fig. 4C), or multiple pores in case of merged tubercles

(Fig. 4E). Slightly different structures occur on the internal mould of the glabella where pits are present just anterior to S0 (Fig. 4C) and on the lateral glabellar lobes (Fig. 4D). This is also the case on the librigenal field where the pits on internal moulds may correspond to pit-like depressions on the dorsal cuticle (Fig. 4B).

Gerastos kippingi n. sp. is a rare species. Of all the proetine specimens we recovered from the Kirberg locality, less than 5 per cent belongs to this species and the remainder to *Dohmiella prescheri*. The firmly impressed lateral glabellar furrows and the well-developed apodemes which are visible on the second to seventh pygidial axial ring of *G. kippingi* n. sp., are common among stratigraphically older proetines including species from Bohemia assigned to *Gerastos* and allied genera by ŠNAJDR (1980). *Gerastos kippingi* n. sp. is otherwise much more similar to *Gerastos cuvieri* than any of these Bohemian species. In turn, *G. cuvieri* is principally different from *G. kippingi* n. sp. as follows: much more strongly vaulted cephalon (sag.,

tr.); anterior border of cranidium does not protrude from cephalic outline; glabella is shorter; lateral glabellar furrows are not as firmly impressed; smaller eyes; posterior pygidial border is narrower (sag., exsag.); weaker apodemes on pygidial axis.

A pygidium identified as *Gerastos* sp. A by VAN VIERSEN & PRESCHER (2008) is largely similar to that of *G. kippingi* n. sp., yet different in having not as firmly impressed axial furrows and apodemes, a surface of axis and pygidial pleural fields devoid of sculpture (except, possibly, for widely distributed pores), more numerous border-parallel terrace lines and a slightly dorsal curvature of the posterior pygidial border adaxially, close to the sagittal line.

***Gerastos arcus* n. sp.**

(Fig. 3; Pl. 2, Figs 11, 14-19)

Derivation of name

From *arcus* (Lat.) = arch, after the arched cephalic outline, upward curved anterior border and downward curved lateral cephalic borders of this species.

Holotype

Incomplete cephalothorax IRSNB a12781 (Pl. 2, Figs 11, 15, 16, 18).

Type locality

Petigny (Loc050), Belgium.

Type horizon

Chavées Member of Jemelle Formation.

Paratypes

Two cephalata (IRSNB a12782, a12783), one mostly exfoliated complete specimen (IRSNB a12784).

Diagnosis

Glabella overhangs anterior cephalic margin when occipital ring is held in the vertical plane. Anterior to lateral cephalic borders are strongly inflated, and distinctly dorsally and ventrally arched respectively. Lateral occipital lobe is accentuated by a single, coarse granule. Ornament on librigena is restricted to granules on weakly inflated subocular ridge. Eyes are large.

Description

Anterior border of cranidium not protruding from cephalic outline. Border furrow of cephalon posterolaterally to laterally shallow, slightly deepening anteriorly. Sagittal length of cephalon is 0.58 relative to maximum width of cephalon. Sagittal length of

glabella anterior to S0 is 0.93 relative to maximum width of glabella, and 0.81 relative to length of cephalon (sag.). Maximum width of glabella is 0.51 relative to maximum width of cephalon. Outline of glabella anterior to S0 is similar to *Gerastos snellingsi* n. sp. but of much less differentiated width (especially lateral to δ). Axial furrows are slightly broadened near the eyes. S0 distinctly broadly W-shaped, slightly to moderately indenting posterior end of anterior glabellar lobe. Width of occipital ring is 0.94 relative to maximum width of glabella. Occipital ring slightly gaining height backwards over entire width, medially bearing several granules around a weak central tubercle; abaxially there are similar, increasingly smaller granules. Lateral occipital lobes are small, fused with occipital ring (isolated if cuticle is exfoliated). Glabella anterior to S0 bearing numerous, not particularly closely spaced tubercles of varying shape. These tubercles become smaller anteriorly. S1 and S2 are moderately weakly impressed. S3 is indiscernible. Preocular sutures converge slightly from β to γ . Postocular sutures run straight posteriorly from ϵ , bending abaxially near the posterior border furrow, then smoothly curving posterolaterally and backwardly towards ω . Surface of fixigena is smooth except anterior to the eye where several small but distinct, randomly scattered tubercles are present. Librigena is weakly vaulted (tr.). Surface of librigenal field is smooth except for subocular ridge. Eye is large. Eye socle is not particularly well-developed. Distance between eye and posterior border is smaller than sagittal length of occipital ring. Posterior border proximally transversally running, flexed 40° posterolaterally at point posterior to δ . Genal angle is somewhat acuminate, reaching backward until lateral to second thoracic axial ring. A genal spine is not developed.

Thorax bears small, randomly scattered granules on postannuli; these granules are slightly more numerous and better developed here medially. On posterior pleural bands sparse, faint granules are present.

The pygidium is only known from a mostly exfoliated, articulated specimen.

Discussion

Gerastos arcus n. sp. is not particularly similar to other members of this genus in the Ardennes except, maybe, for the stratigraphically much younger *Gerastos snellingsi* n. sp. The former is different from the species from Wellin in having a more adaxially positioned ω ; shorter distance between eye and posterior border; less sloped (tr.) librigenal field; larger, more widely spaced tubercles on glabella anterior to S0; better developed,

more numerous terrace lines discernible dorsally on the more vaulted anterior to lateral cephalic borders; larger eyes; librigenal field devoid of sculpture except on subocular ridge.

***Gerastos rommersheimensis* n. sp.**
(Figs 3, 6; Pl. 2, Figs 1-10, 12, 13;
Pl. 4, Figs 12, 15, 18)

- ? 2002 — *Gerastos prox* ssp. n. P – BASSE, pl. 7, figs 115, 116.
? 2003 — *Gerastos prox* ssp. cf. *prox* ssp. n. P – BASSE, pl. 29,
fig. 483.

Derivation of name

After the type locality.

Holotype

Cephalon IRSNB a12752 (Pl. 2, Figs 1-3).

Type locality

Rommersheim (Rommersheim01), Germany.

Type horizon

Eilenberg Member of Freilingen Formation.

Paratypes

One disarticulated specimen (IRSNB a12753), two cephalons (IRSNB a12754, a12755), two pygidia (IRSNB a12751, a12756); all from type locality and horizon.

Diagnosis

Librigenal field bears numerous coarse granules, especially adaxially; subocular ridge is undeveloped. Glabella is distinctly widened (tr.) opposite δ . Eyes are small. Pygidial axis moderately strongly vaulted (tr.). Pygidial border is uniformly broad.

Discussion

The *Gerastos* material from Rommersheim is profuse (> 500 disarticulated sclerites to complete exoskeletons) but of strongly varying quality. The majority of specimens were severely affected by tectonic deformation, disintegration of the cuticle or a combination of these factors, so that they cannot be precisely identified despite the fact that many of them are complete. Most individuals have numerous small tubercles on the glabella whereas a smaller portion bears fewer, larger tubercles here. These differences remind of *Gerastos* material recorded from around the Eifelian–Givetian transition in the Holy Cross Mountains by KIELAN (1954), who identified all her specimens as *Gerastos granulatus* while regarding the large-tubercled forms as juveniles. BASSE (2002, p. 21) did not distinguish between any of his specimens from Rommersheim in assigning them all to *Gerastos prox* n. ssp. P, undoubtedly because of material deficiency. We do not attribute the two forms from Rommersheim to distinct ontogenetic stages nor do we incorporate them in a single, possibly polymorphic species. Study

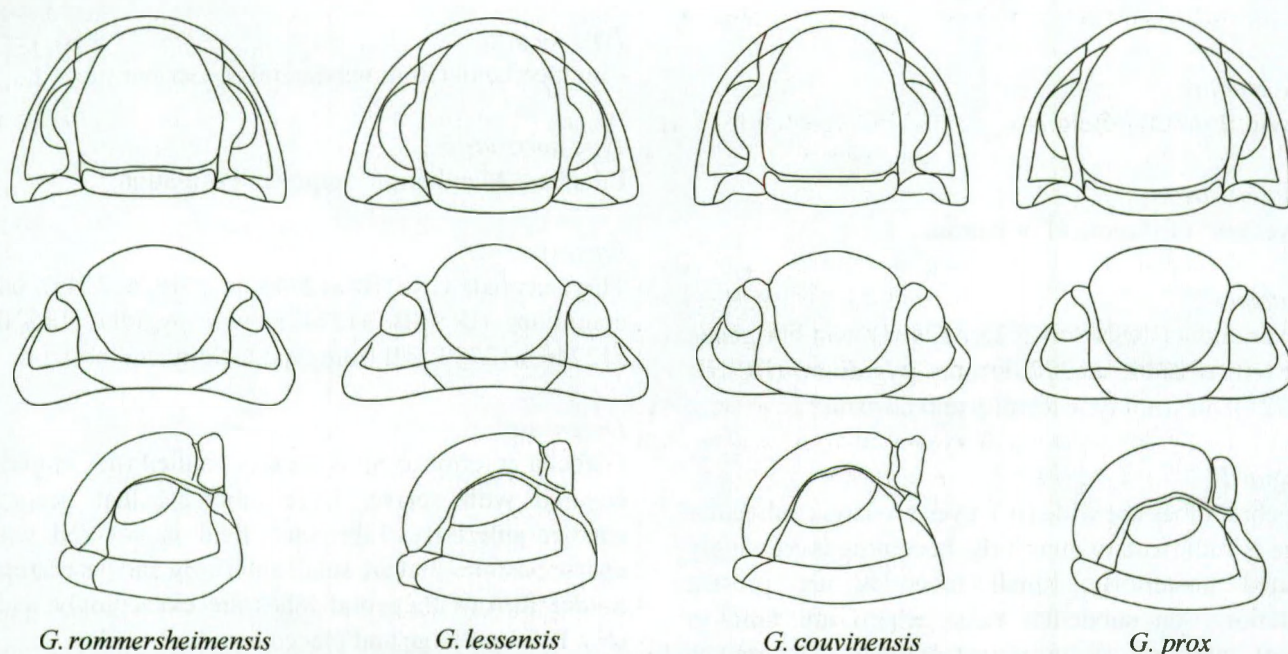


Fig. 6 – Schematic line drawings of *Gerastos rommersheimensis* n. sp., *Gerastos lessensis* VAN VIERSEN & PRESCHER, 2008, *Gerastos couvinensis* n. sp. and *Gerastos prox* (RICHTER & RICHTER, 1956).

of the better preserved specimens did not support this for several reasons: 1) the large-tubercled form is rarer, 2) the majority of specimens approach the maximum size of the particular form that they belong to, i.e., most are probably large holaspides rather than juveniles, and 3) there are no transitional forms. Based on the well-preserved specimens we recognise two distinct taxa, namely *Gerastos rommersheimensis* n. sp., characterised by a broadly parabolic, moderately strongly vaulted (tr.) cephalon; narrow (tr.) palpebral lobes; numerous small tubercles on glabella and librigenal field; pygidium of subsemicircular outline; moderately strongly vaulted (tr.) pygidial axis; four to five terrace ridges visible dorsally on posterior pygidial border; and *Gerastos batrachus* n. sp., characterised by a widely subsemicircular, weakly vaulted (tr.) cephalon; exceedingly wide (tr.) palpebral lobes; large, more widely spaced tubercles on glabella and librigenal field; widely rounded pygidium with posterior border somewhat straightened (tr.) medially; weakly vaulted (tr.) pygidial axis; two terrace ridges visible dorsally on posterior pygidial border.

***Gerastos couvinensis* n. sp.**
(Figs 3, 6; Pl. 3, Figs 1-13)

Derivation of name

After the type locality.

Holotype

Complete specimen NHMM 2009070 (Pl. 3, Figs 1-6, 8).

Type locality

Couvin (Loc021), Belgium.

Type horizon

Lower part of Hanonet Formation.

Paratypes

Two cranidia (IRSNB a12725, a12733), two librigenae (IRSNB a12719, a12720), one pygidium (IRSNB a12721); all from type locality and horizon.

Diagnosis

Palpebral lobes are wide (tr.); eyes are large; subocular ridge is rudimentary anteriorly, becoming increasingly inflated posteriorly; small tubercles are present posteriorly on subocular ridge which are faint to absent anteriorly. Antermost pygidial axial ring is exceedingly narrow (exsag.) abaxially.

Discussion

Gerastos prox differs from *Gerastos couvinensis* n. sp. mainly as follows: anterior cranial border distinctly protrudes from cephalic outline; smaller eyes; more tapered (tr.) and more strongly vaulted (tr.) glabella; narrower (tr.) palpebral lobes; more inflated subocular ridge bearing larger tubercles; more vaulted pygidium (tr.); pygidial border with more terrace ridges visible dorsally, especially posteromedially; anteriormost pygidial axial ring is broad (exsag.) abaxially.

Gerastos lessensis is primarily distinguished from the new species from Couvin by its more inflated cephalic borders; smaller eyes; subocular groove is usually shallower; subocular ridge is less inflated and bears granules or occasionally several tubercles posteriorly; glabella anterior to S0 is longer, straightened near S1; pygidial axis is more vaulted (tr.).

***Gerastos batrachus* n. sp.**

(Fig. 3; Pl. 4, Figs 1-11, 13, 14, 16, 17)

? 2002 — *Gerastos prox* ssp. n. P – BASSE, pl. 7, figs 113, 114, 117.

Derivation of name

From βάτραχος (Greek) = frog, after the ranine appearance of the cephalon of this species in anterior view.

Holotype

Cephalon IRSNB a12744 (Pl. 4, Figs 1-3, 7).

Type locality

Rommersheim (Rommersheim01), Germany.

Type horizon

Eilenberg Member of Freilingen Formation.

Paratypes

Three cephalata (IRSNB a12745, a12748, a12749), one cranidium (IRSNB a12747), two pygidia (IRSNB a12746, a12750); all from type locality and horizon.

Diagnosis

Glabella anterior to S0 is weakly vaulted (tr.), entirely covered with sparse, large tubercles that become smaller anteriorly. Librigenal field is covered with coarse pustules that are small anteriorly and near lateral border furrow. Palpebral lobes are exceedingly wide (tr.). Eyes are large and placed on a high socle.

Description

Anterior border of cranidium is dorsally flattened medially, and protrudes somewhat from broadly subsemicircular cephalic outline. Cephalic border is upward curved adaxially in anterior view, faintly downward curved in lateral view. Three terrace ridges are visible dorsally on outer half of anterior border and very fine granules on inner half. Cephalic border furrow is narrow but deep. Outline of glabella anterior to S0 is rounded subquadratical. Axial furrow is broadened near eye. S0 is a transverse line that only broadens (exsag.) distally. Occipital ring bears several granules around a small, somewhat posteriorly positioned median tubercle and few granules nearby. Lateral occipital lobes are rudimentary, and not isolated. Glabella anterior to S0 bears moderately few, coarse, large tubercles that are still distinct anteriorly albeit markedly smaller. S1 and S2 are very weakly impressed. S3 is indiscernible. Preocular sutures are slightly divergent between α and γ . Postocular sutures run almost straight backwards from ϵ to ζ and then strongly diverge towards ω . Surface of fixigena is smooth except for several fine granules anterior to the eye. Librigena is very weakly vaulted (tr.). Subocular ridge is absent. Distance between eye and posterior border is smaller than sagittal length of occipital ring. Posterior border entirely subtransversally running. Genal angle is pointed but a thorn or spine is never developed.

Pygidium is moderately weakly vaulted (sag., tr.). Contour is broadly rounded subtrapezoidal. Sagittal length (including preannulus) of pygidium is 0.55 relative to maximum width. Length (sag.) of axis is 0.85 relative to sagittal length of pygidium. Maximum width of axis is 0.83 relative to sagittal length of axis, and 0.39 relative to maximum width of pygidium. Length of terminal axial piece is 0.09 relative to sagittal length of pygidium. Pygidial border is gently downward sloped, broadening from anteriorly backwards, broadest point is attained posterolaterally, adaxially from which border is narrows again (sag., exsag.). Anterolaterally one or two terrace ridges are visible dorsally on pygidial border, posterolaterally to posteriorly there are two. Axis tapers more or less proportionally backwards (width of seventh axial ring relative to first is 0.56). Seven, broadly M-shaped axial rings plus terminal axial piece are present. Pleural fields with six pairs of smoothly posterolaterally curved pleurae. Pleural furrows are more firmly incised than interpleural furrows, especially posteriorly. Border furrow is developed as a slope discontinuity between pleural fields and pygidial border. Axial rings bear few granules; lateral axial lobes are weakly inflated and devoid of sculpture. Pleural

fields are devoid of granules. Pygidial border bears closely spaced, fine granules.

Discussion

KIELAN's (1954, pl. 1, figs 1, 2, 5) material of *Proetus* (*Proetus*) *granulosus* from the Holy Cross Mountains includes a number of specimens that bear a striking resemblance to *Gerastos batrachus* n. sp. Among features in common are the broadly rounded cephalon; sparse, large tubercles on the glabella anterior to S0; a distinct median tubercle on the occipital ring close to its posterior margin; wide (tr.) palpebral lobes; and a similar glabellar outline in lateral view. The Polish specimens are largely dissimilar in having an inflated subocular ridge that bears a row of tubercles, and the absence of tubercles elsewhere on the librigenal field.

Gerastos snellingsi n. sp.

(Fig. 3; Pl. 5, Figs 1-8)

Derivation of name

Named after Jules Snellings (Wellen, Limburg), who collected and kindly donated the holotype for study.

Holotype

Complete specimen NHMM 2009069 (Pl. 5, Figs 1-8).

Type locality

Wellen (Loc006a), Belgium.

Type horizon

Upper part of Hanonet Formation.

Diagnosis

Anterior to lateral cephalic borders are levelled; upward curved only towards genal angle. Sculpture on glabella consists of closely spaced, moderately small tubercles between S0 and S3, slightly smaller, more widely spaced tubercles on frontal part. Librigenal field is steep; weakly vaulted (tr.). Subocular ridge is rudimentary, bearing colliculate, bladder-like tubercles. Postocular sutures are strongly divergent, with ω positioned near the genal angle.

Description

Contour of cephalon is parabolic. Anterior border of cranidium does not clearly protrude from cephalic outline. Three to four, moderately distinct terrace ridges are visible dorsally on anterior border. Anterior border is slightly dorsally flattened medially (tr.). Border furrow of cephalon is narrow, not particularly deep. Sagittal

length of cephalon is 0.33 relative to sagittal length of entire exoskeleton, and 0.58 relative to maximum width of cephalon. Sagittal length of glabella anterior to S0 is 0.91 relative to maximum width of glabella and 0.78 relative to length of cephalon (sag.). Maximum width of glabella is 0.51 relative to maximum width of cephalon. Outline of glabella anterior to S0 is broadly parabolic between anterior margin and δ , from where it tapers steadily backwards just beyond a point lateral to posterior margin of eye. Axial furrow is uniformly broad. S0 broadly W-shaped, indenting posterior end of anterior glabellar lobe. Width of occipital ring is 0.90 relative to maximum width of glabella. Occipital ring slightly gaining height backwards over entire width, bearing several small tubercles and granules medially. There are two tubercles that are positioned medially on the occipital ring (one centrally and one posteriorly), one of which may be the true median tubercle that is also seen here in many congeners. Lateral occipital lobes are fused with occipital ring, accentuated mainly by the presence of several large granules. S1 and S2 weakly are impressed, recognisable mainly by the absence of sculpture in these areas. S3 is faint. Preocular sutures converge slightly from β to γ . Postocular sutures run concavely posteriorly from ϵ , flex abruptly posterolaterally near posterior border furrow and from there run obliquely towards ω . Surface of fixigena is smooth except anterior to eye where small but distinct, closely spaced tubercles are present. Eyes are moderately large. Eye socle is weakly defined. Subocular groove broadens gradually backwards. Surface of librigenal field abaxial to subocular ridge bears a mixture of small pits and sparse tubercles and granules of varying size. Posterior border proximally transversally running, from posterior to δ flexed 40° posterolaterally. Genal angle reaches backward until lateral to first thoracic axial ring. The tip of the genal angle is not preserved but there is no impression of a genal spine visible on the matrix.

Thorax is comprised of ten segments. Axis tapers backwards (transversal width of tenth axial ring relative to first is 0.80). Faint, randomly scattered granules are present on the postannuli and posterior pleural bands.

Pygidium is not particularly strongly vaulted (sag., tr.). Contour is rounded subtrapezoidal. Sagittal length (including preannulus) of pygidium is 0.59 relative to maximum width. Length (sag.) of axis is 0.83 relative to sagittal length of pygidium. Maximum width of axis is 0.81 relative to sagittal length of axis, and 0.40 relative to maximum width of pygidium. Length of terminal axial piece is 0.15 relative to sagittal length of pygidium. Pygidial border is gently downward sloped along with

pleural fields, broadening backwards; broadest point is attained posterolaterally, adaxially from which border is slightly more downward sloped but of unchanged width (sag., exsag.). Anterolaterally two terrace ridges are visible dorsally on pygidial border, posterolaterally to posteriorly there are three. Axis tapers proportionally backwards (width of seventh axial ring relative to first is 0.62). Seven axial rings plus long (sag., exsag.) terminal axial piece are present. First axial ring is smoothly backward curved distally; lateral axial lobe is fused. The following six rings are broadly M-shaped (less so backwards in each ring), with weakly inflated lateral axial lobes. First two inter-ring furrows are most firmly incised; third and fourth inter-ring furrows are only medially well-impressed; remaining inter-ring furrows are increasingly shallow. Pleural fields comprise six pairs of smoothly posterolaterally curved pleurae. Pleural furrows are slightly more deeply incised than interpleural furrows. Border furrow is rudimentary, especially anteriorly near first pleura and anterior band of second pleura. Axial rings bear randomly scattered granules; these granules are rarely present on the lateral axial lobes. Pleural fields and pygidial border are devoid of granules.

Discussion

Just a single specimen was recovered of this species but which is of exceptional quality for a trilobite from Belgium considering that these are usually tectonically deformed (see Pl. 3, Figs 1-6, 8, for a typical, mildly deformed specimen). The left librigena (unfigured) is inverted and lies left, adjacent to the cephalon; the fissures that traverse the exoskeleton are taphonomic in origin.

Given its Early Givetian age, *Gerastos snellingsi* n. sp. might have been expected to be morphologically close to *Gerastos eiffliensis* from the Lower Givetian (Loogh and Cürten Formations) in the Eifel or even to *Gerastos prox.* Instead, the plump glabella, far abaxially positioned ω , and weakly developed pygidial border render *G. snellingsi* n. sp. very different from these species.

Gerastos snellingsi n. sp. is more similar to *Gerastos umberianus* (ALBERTI, 1969) and *Gerastos prox.* cf. *umberianus* of FEIST & ORTH (2000) approximately from the Eifelian–Givetian transition in Morocco. It is principally different from these species in having smaller tubercles on the glabella and pygidial axis, a wider (tr.) glabella, especially near S1, and a generally more strongly vaulted (tr.) cranidium and pygidium. The librigenae of all three taxa are inadequately known so that they cannot be compared at this time.

Genus *Dohmiella* LÜTKE, 1990

Type species: Proetus (Euproetus) dohmi RICHTER & RICHTER, 1918 from the Eifelian of the Eifel.

Dohmiella acanthonota n. sp.
(Pl. 6, Figs 1-16; Pl. 7, Figs 1-5)

Derivation of name

From *acantha* (Lat.) = thorn, spine, and *notos* (Lat.) = back, referring to the spiny thoracic and pygidial axes of this species.

Holotype

Pygidium IRSNB a12766 (Pl. 6, Figs 5, 6, 8, 9).

Type locality

Gerolstein (Gerolstein02), Germany.

Type horizon

Köll Member of Ahrdorf Formation.

Paratypes

Two cranidia (IRSNB a12764, a12773), one juvenile cranidium (IRSNB a12765), two librigenae (IRSNB a12769, a12771), one incomplete specimen (IRSNB a12770), three pygidia (IRSNB a12767, a12768, a12772).

Diagnosis

Frontal part of glabella bears small, faint tubercles. Lateral border furrow of cephalon is concavely rounded in section (tr.). Posterior two thoracic axial rings and anterior pygidial axial ring bear a stout, short median spine. Wide (tr.) pygidium comprising anteriorly wide (tr.) pleural fields that drop concavely towards borders.

Discussion

Conspicuous about *Dohmiella acanthonota* n. sp. is the pronounced row of median spines on the thoracic and pygidial axes. On the thorax, these spines are increasingly large backwards until they reach their acme on the posteriormost ring. A slightly shorter spine is present on the anteriormost pygidial axial ring from where the subsequent rings bear drastically reduced ones. None of our specimens have the spines fully preserved but their current lengths clearly exceed those of known other *Dohmiella* species. Well-preserved specimens of *Dohmiella chamaeleo* (RICHTER & RICHTER, 1918, p. 67; and pers. comm. with J. Savelsbergh), for instance, demonstrate similarly arranged but generally

smaller spines. The same configuration is displayed by a number of other Devonian proetids including species from Morocco assigned to *Tropidocoryphe* (*Tropidocoryphinae*) by CHATTERTON *et al.* (2006) and *Timsaloproetus* (*Cornuproetinae*) by GIBB & CHATTERTON (2007) and an undescribed species of *Phaetonellus* (*Eremiproetinae*) e.g. by BONINO & KIER (2009). The presence of such axial structures is scattered among members of Proetidae and it seems likely that these features are often the result of convergent evolution.

Dohmiella prescheri and *Dohmiella stumporum* from the Eifel are easily distinguished from *D. acanthonota* n. sp. by their narrower (tr.) librigenal field (with the eye positioned closer to the lateral border); glabella that is distinctly constricted near S2; and generally different sculpture. *Dohmiella dewildei* from the Ardennes shares with the new species the densely spaced, coarse granules on the pygidial pleural field, and at least one of the thoracic axial rings bears a short median spine (VAN VIERSEN, 2006b, pl. 1, fig. 3). The Belgian species is different in having a wider (tr.) librigenal field; smaller eyes; much more smoothly rounded pygidial contour; frontal part of glabella is devoid of sculpture; an acuminate median tubercle instead of a short spine on the first pygidial axial ring; better developed lateral occipital and pygidial lateral axial lobes.

Subfamily Tropidocoryphinae PRIBYL, 1946

Genus *Astycoryphe* RICHTER & RICHTER, 1919

Type species: Astycoryphe senckenbergiana RICHTER & RICHTER, 1919 from the Eifelian of the Eifel.

Discussion

Astycoryphe has been characterised as a highly conservative member of Tropidocoryphinae (see FEIST & CLARKSON, 1989). Indeed, when reviewing the previously published material from the Ardennes and Eifel there seem to be few significant morphologic changes in members of this genus. On the other hand, *Astycoryphe* is rare in these regions and the majority of few known sclerites have been lumped together with the type species, *A. senckenbergiana* from the middle Eifelian at the "Trilobitenfelder" of Gees, regardless of their morphology and provenance. In fact, none of the paratypes of *A. senckenbergiana* are topo- or stratotypical (see BASSE, 2002, p. 70, for details) for as RICHTER & RICHTER (1919) suggested, they are difficult to distinguish from the holotype. One of us

(AVV) examined the holotype in the collections of the Senckenberg Museum (Fig. 7) and concluded that its cephalon and especially glabella are damaged to such an extent that the paratypes which are cephalic parts, though they appear to be very similar, may not be conspecific. We prefer a tentative assignment of these paratypes to *A. senckenbergiana*, at least until more material is described from each of the localities that they came from. Unfortunately, to our knowledge, scant topo- and stratotypical sclerites have been found which all reside in private collections (also see remarks made earlier by KOWALSKI, 1989). The closure of the "Trilobitenfelder" in 1984 (e.g. KOWALSKI, 1986) impedes the recovery of indispensable additional material.

Astycoryphe exilis n. sp.
(Pl. 7, Figs 6-13)

Derivation of name

From *exilis* (Lat.) = slender, after the narrow cranidium and glabella of this species.

Holotype

Cranidium IRSNB a12729 (Pl. 7, Figs 6, 8, 9, 12).

Type locality

Couvin (Loc021), Belgium.

Type horizon

Lower part of Hanonet Formation.

Paratypes

One external mould of a fragmentary cranidium (IRSNB a12722), one partial cranidium (IRSNB a12730), one librigena (IRSNB a12734); all from type locality and horizon.

Diagnosis

Cephalon and glabella are moderately strongly vaulted (tr.). Cranidium and glabella are narrow (tr.). Palpebral lobe is broad (tr.). Preglabellar field, adaxial part of palpebral lobes, and L1 and L2 bear randomly scattered, small pits. Lateral glabellar furrows S1 and S2 are firmly impressed. Cephalic borders are strongly inflated.

Description

Contour of cephalon is broadly rounded. Anterior border is moderately strongly vaulted, bearing four, well-defined, border-parallel terrace ridges. Glabella anterior to S0 broadens slightly between the front and

S2, strongly between S2 and S1, and slightly between S1 and S0. Palpebral lobe bears short, randomly oriented terrace ridges abaxially. β is positioned further abaxially than δ ; δ is positioned opposite S1. Glabella is well-demarcated anteriorly and laterally by deep furrows. S0 is narrow (sag., exsag.), shallow, and widens (exsag.) only abaxially. S1 and S2 are firmly impressed so that L1 and L2 are well-defined. S3 is indiscernible. The entire glabella is covered with randomly oriented terrace ridges that are distinctly inflated especially posteromedially. Occipital ring is not higher than rest of glabella and bears a particularly strong central tubercle. Preglabellar and librigenal fields are slightly more downward sloped outside of the tropidium. Lateral and posterior borders are strongly vaulted. Proximal part of genal spine is not particularly well-developed (when compared to e.g. *Astycoryphe jorusi* n. sp.). Librigenal field is devoid of ornament.

Discussion

This species is very different from coeval *Astycoryphe jorusi* n. sp. coming from the same formation in Rosteigne in having small pits on parts of the cranidium; better developed tropidium; narrower (tr.) cranidium and glabella; S2 and S3 much more firmly impressed; and wider (tr.) palpebral lobes. These same criteria may be used to discriminate *Astycoryphe exilis* n. sp. from *Astycoryphe senckenbergiana* as the latter seems to have a cephalon similar to *A. jorusi* n. sp. (see below). The specimens of *A. exilis* n. sp. are generally smaller than those of *A. jorusi* n. sp. from Rosteigne, but, because the former are all of similar size, we do not expect them to be juveniles. This is endorsed by the fact that proetids from Couvin are generally smaller than those from Rosteigne. For example, the holotype of *Gerastos couvinensis* n. sp., if it had been outstretched, is an average-sized specimen at about 13 mm sagittal length whereas *Gerastos lessensis* specimens from Rosteigne (especially when coming from the shaly, basal part of the Hanonet Formation here) can easily attain 20 mm. Likewise, the holotype cranidium of *Cornuproetus latentissimus* n. sp. from Couvin measures 6 mm (sagittal length) compared to 9 mm for a cranidium recorded from Rosteigne. One juvenile pygidium of *A. jorusi* n. sp. shows prominent pits on the pygidium between the pleural ribs which are similar to, yet larger than those on the cranidium of *A. exilis* n. sp. They may imply a paedomorphic origin for the pits in *A. exilis* n. sp. though additional ontogenetic material will be needed to verify this.

A similar case of two *Astycoryphe* species occurring in a single formation in different localities was

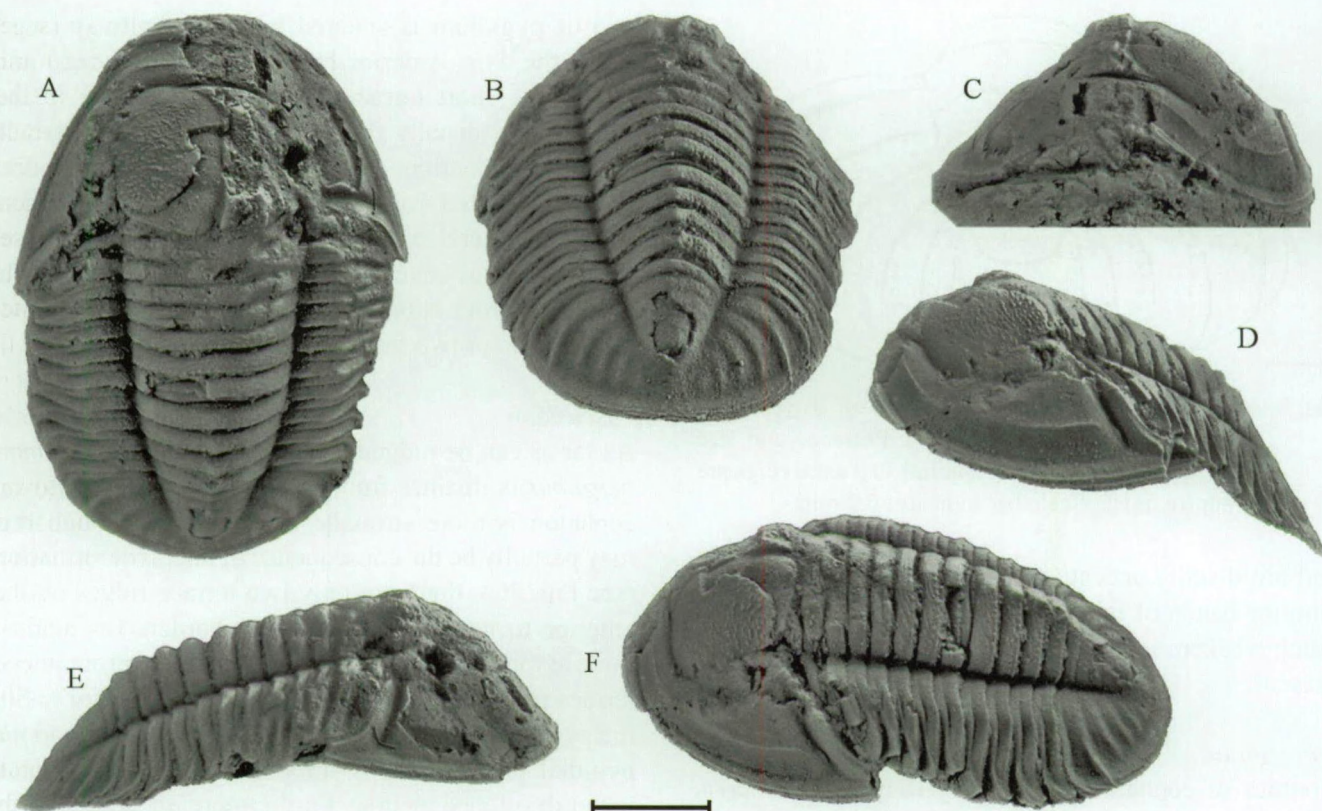


Fig. 7 – Holotype of *Astycoryphe senckenbergiana* RICHTER & RICHTER, 1919 (SMF 58449) from the Gees Subformation of the Ahrdorf Formation at the “Trilobitenfelder” of Gees, Eifel. Dorsal views of cephalon (A) and pygidium (B), and anterior (C), oblique anterolateral (D), lateral (E) and oblique lateral (F) views. Scale bar indicates 2 mm.

documented from the Canadian Arctic by ORMISTON (1967). One of these, *Astycoryphe arcticus* ORMISTON, 1967, is known from the cranidium alone. Like *A. exilis* n. sp. and *A. jorusi* n. sp., the cranidium of *A. arcticus* is very different from *Astycoryphe cimelia* ORMISTON, 1967 in the same formation which in turn stands closer to *A. senckenbergiana*.

Astycoryphe exilis n. sp. reminds of the basic body plan and especially the narrow glabella anterior to S0 of *Longicoryphe* species from Givetian strata in the Montagne Noire including *Tropidocoryphe* (*Longicoryphe*) aff. *brilonensis* of FEIST (1976, pl. 2, fig. 5a), but it has a longer glabella; longer palpebral lobes; and less divergent preocular sutures. These characters indicate that it stands much closer to other *Astycoryphe* species than to *Longicoryphe*.

***Astycoryphe jorusi* n. sp.**
(Fig. 8; Pl. 8, Figs 1-13)

v 2008 — *Astycoryphe* sp. – VAN VIERSEN & PRESCHER, p. 10.

Derivation of name

In honour of someone dear to Alfer van

Rossum, who collected and kindly donated the holotype and several of the paratypes for study.

Holotype

Pygidium IRSNB a12761 (Pl. 8, Figs 7, 10).

Type locality

Resteigne (Loc002), Belgium.

Type horizon

Lower part of Hanonet Formation.

Paratypes

One cranidium (IRSNB a12759), one incomplete cranidium (IRSNB a12763), three librigenae (IRSNB a12758, a12760, a12762), one juvenile pygidium (IRSNB a12757); all from type locality and horizon.

Diagnosis

Pygidial pleural fields are weakly vaulted (tr., exsag.) and dorsally flattened. Anterior bands of anterior two pygidial pleurae are rudimentary adaxially, increasingly inflated and widened (exsag.) abaxially, narrowed again towards lateral border, reach the pygidial margin,

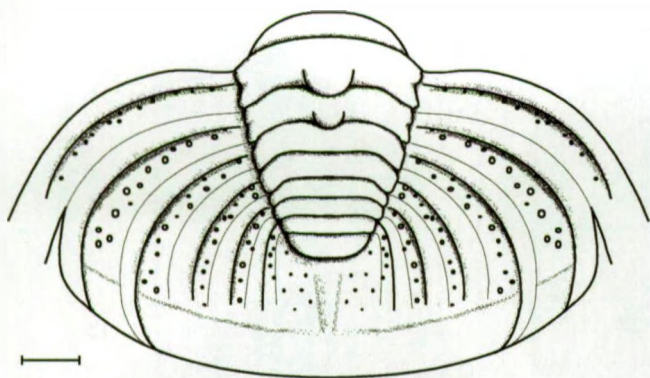


Fig. 8 – Drawing of juvenile pygidium of *Astycoryphe jorusi* n. sp. (IRSNB a12757). Presence and size of median tubercles on anterior two axial rings are approximate. Scale bar indicates 0.2 mm.

and are distally accentuated by a single terrace ridge; anterior bands of third to fifth pleurae are similar but much weaker; an indiscernible sixth pair of pleurae is present.

Description

Contour of cephalon is convexly rounded. Border is weakly vaulted anteriorly to dorsally flattened laterally towards genal angle. Border furrow is groove-like and shallow anteriorly to laterally, becoming faint near genal angle; posterior border furrow on the other hand, is deep. Preglabellar field is devoid of sculpture. Axial furrow is moderately weakly impressed anteriorly, weakly impressed near δ , and deep near S0. Palpebral lobe is narrow, bearing short terrace ridges posteriorly, and transversally elongated ones anteriorly. Glabella anterior to S0 is weakly vaulted (tr.), not well-demarcated, broadening significantly between S3 and S1, narrowing slightly between S1 and S0, covered with short terrace ridges which are very short posteriorly and increasingly elongated anteriorly where they verge to form fused, subtransversal terrace ridges. Sculpture similar to this is displayed by the occipital ring which are abaxially both weak and increasingly posterolaterally oriented; furthermore, a moderately strong median tubercle is present just anterior to the middle (sag.). Occipital ring is lower than anteriorly lying part of glabella. Librigena is weakly vaulted (tr.), anteriorly devoid of sculpture, posteriorly there are broad, flattened tubercles situated just anterior to posterior border furrow and alternated by few granules. Tropicidium is fine but distinct throughout.

Pygidium is widely rounded, weakly vaulted, especially medially, although fissures in the left and right pleural fields indicate that dorsal tectonic deformation may, in part, account for this. Widest point

(tr.) of pygidium is situated lateral to halfway (sag.) along the axis. Anterior border is broad (exsag.) and bears few, short terrace ridges adaxially and in the middle (tr.); distally there are two continuous terrace ridges that continue onto the lateral border. Pleural field is separated from anterior border by a wide groove and from lateral border by a distinct slope. Pygidial axis comprises seven rings plus terminal axial piece. Pygidial border is only developed as a flattened band, bearing one or two fine terrace ridges dorsally.

Discussion

As far as can be judged from its holotype, *A. senckenbergiana* is distinct from *A. jorusi* n. sp. as follows: cephalon is more strongly vaulted (tr.) although this may partially be the consequence of lateral deformation (see Fig. 7C); there are only two terrace ridges on the anterior to anterolateral cephalic borders (as against three to four in *A. jorusi* n. sp.); larger, more pronounced terrace ridges are present on the glabella anterior to S0; the pygidial axis is comprised of only six rings; and the pygidial pleural field is smoothly vaulted with much better developed pleurae. Furthermore, the new species bears very weak, flattened tubercles on the posterior two-third of the librigenal field and abaxial to the tropidium; and fine granules posteriorly on the librigenal field, adjacent to the posterior border furrow.

KIELAN (1954) recorded cephalic and pygidial remains from the Eifelian–Givetian transition in the Holy Cross Mountains which she assigned to *A. senckenbergiana*. Although the Polish specimens are difficult to identify based on the small illustrations, the well-developed pygidial pleurae and pygidial border furrow suggest that they belong to a different species than ours. ORMISTON (1967) noticed the striking resemblances between KIELAN's material and *A. cimelia*, and he reasoned that the former belongs to his species rather than to *A. senckenbergiana*. *A. cimelia* shares with *A. jorusi* n. sp. the weakly vaulted (tr.) cranidium and (at least) seven pygidial axial rings but it is clearly dissimilar in having seven, distally well-developed, more backward-curved, pygidial pleurae, and a more strongly tapered pygidial axis.

A pygidium which was recorded by MAGREAN (2006) from the middle Eifelian in Jemelle and assigned to *A. senckenbergiana* is different from that and our species in having a rudimentary pygidial border and more backward curved pygidial pleurae.

Astycoryphe sp. B

(Pl. 11, Fig. 7)

v 2006b — *Astycoryphe* sp. — VAN VIERSEN, p. 231.*Material*

One librigena and a partial external mould of another librigena on a single rock slab (IRSNB a12718) from the Foulerie Member of the Couvin Formation at Nismes (Loc028), Belgium.

Discussion

The specimens from Nismes represent the stratigraphically earliest known occurrence of *Astycoryphe* in Belgium. BASSE (2002, pl. 28, figs 561-564) figured several sclerites from the lower Eifelian of the Eifel that he assigned to *Astycoryphe senckenbergiana*. Among BASSE's material is a librigena which is principally different from ours in having a broader (tr.) librigenal field.

Astycoryphe sp. B is similar to, yet distinct from *Astycoryphe jorusi* n. sp. in having a broad, concave lateral border furrow, weaker vaulted borders that bear less terrace ridges and a trogidium that approaches the visual surface more closely.

Subfamily Cornuproetinae RICHTER, RICHTER & STRUVE in MOORE, 1959

Genus *Cornuproetus* RICHTER & RICHTER, 1919

Type species: Gerastos cornutus GOLDFUSS, 1843 from the Eifelian of the Eifel.

Cornuproetus latentissimus n. sp.

(Pl. 9, Figs 1-11)

v 2007 — *Cornuproetus cornutus* n. ssp. 1 — VAN VIERSEN, pp. 21-22, pl. 2, figs 1, 3, 4.*Derivation of name*

This species has been known from librigenal and pygidial remains in Couvin whereas its cranidium remained elusive. A similar cranidium was recently found in Resteigne and is the first indication of its previously suspected occurrence there. Hence the name *latentissimus* (Lat.) = hidden, concealed.

Holotype

Cranidium IRSNB a12726 (Pl. 9, Figs 1, 3, 6).

Type locality

Couvin (Loc021), Belgium.

Type horizon

Lower part of Hanonet Formation.

Paratypes

One slightly tectonically deformed librigena (IRSNB a12728), one thorax segment (IRSNB a12727), one thorax segment on the same rock slab as the holotype cranidium of *Astycoryphe exilis* n. sp. (IRSNB a12729); one pygidium with associated external mould (IRSNB a12724); all from type locality and horizon. One librigena (IRSNB a12447) and one pygidium (IRSNB a12448) come from the same formation (presumably lower part) at the type locality (VAN VIERSEN, 2007, pl. 2, figs 1, 3, 4; the librigena is refigured herein on Pl. 9, Fig. 8).

Other material

Tentatively assigned is an incomplete cranidium (IRSNB a12731) from the Hanonet Formation (upper Eifelian) at Loc002, Resteigne (= *Cornuproetus* cf. *latentissimus* n. sp.).

Diagnosis

Dorsal sculpture on entire pleural lobe of exoskeleton is dominated by terrace ridges alternated by granules, except on pygidial border. Occipital ring is abaxially short (exsag.). Thoracic and pygidial axial rings bear terrace ridges anteriorly to laterally and coarse granules posteromedially.

Description

Anterior border of cranidium bears three distinctly raised terrace ridges dorsally on outer half; numerous, fine, shorter terrace ridges on inner half. Anterior border furrow is narrow. A preglabellar field is not developed. Glabella anterior to S0 is slightly constricted near S2; widest near L1. S1 to S3 are weakly impressed, mostly visible due to the lack of sculpture here. Glabella is otherwise covered with densely spaced, granules which are coarse and of rounded outline posteriorly, and increasingly transversally to somewhat concentrically elongated anteriorly where they verge to forming fused ridges. Axial furrow is moderately deep near frontal part of glabella and L1; deep near S2 and S0. S0 is a subtransversal line. Occipital ring bears fine, elongated terrace ridges on anterior one-third; posterior from here are coarse granules that are similar to, but slightly more spaced than on glabella just anterior to S0. A median node is present on the occipital ring just anterior to the middle (sag.).

Discussion

VAN VIERSEN (2007) described and illustrated a librigena and a pygidium of this species from the type locality but which were not collected *in situ*. These specimens are thus of imprecise stratigraphic origin and it was concluded that they came from the late Eifelian or Early Givetian part of the Hanonet Formation. This author also commented that, despite many similarities between the trilobite assemblages of the Hanonet Formation in Couvin and Resteigne *Cornuproetus* remained elusive in the latter locality. We recovered new *Cornuproetus* material from three outcrops, Couvin (*Cornuproetus latentissimus* n. sp.), Resteigne (*Cornuproetus* cf. *latentissimus* n. sp.) and Olloy-sur-Viroin (*Cornuproetus* sp. 3), all of which came from the lower part of the Hanonet Formation, i.e., the upper Eifelian. There is currently no evidence that *Cornuproetus* approaches the Givetian boundary in any of these localities and so we assume that VAN VIERSEN's (2007) specimens from Couvin are of a late Eifelian age. The cranidium from Resteigne comes from a basal horizon in the Hanonet Formation and is probably slightly older than the specimens from Couvin. Despite its inferior preservation it can be distinguished through its shorter, more vaulted (tr.) glabella anterior to S0; more terrace ridges on outer half of anterior border; and abaxially longer (exsag.) occipital ring.

KIELAN (1954, pl. 2, fig. 12) illustrated a trilobite pygidium from the Eifelian–Givetian transition in the Holy Cross Mountains which she assigned to *Otarion* (*Otarion*) sp. This specimen appears to belong to *Cornuproetus* or a closely related genus but it is too poorly preserved for a detailed comparison.

Cornuproetus marrakechensis ALBERTI, 1969 from around the Eifelian–Givetian transition in Morocco is different in having a more convex (sag., exsag.) anterior border; wider (tr.) anterior glabellar lobe; absence of terrace ridges anteriorly on the occipital ring; wider (tr.) palpebral lobes; abaxially longer (exsag.) occipital ring. The Moroccan taxon was originally ascribed by ALBERTI to a subspecies of *Cornuproetus cornutus* but according to BASSE (2002, p. 63) this classification is difficult to adopt since it is known from the cranidium alone.

FEIST & ORTH (2000) recorded cranidial and pygidial remains from basal Givetian strata in Morocco which they assigned to a new species *Cornuproetus oudrissensis*. The cranidium of the Belgian species is different in having a longer glabella, the absence of a preglabellar field, smaller granules (especially bordering the palpebral lobes) which are transversally elongated on frontal part of glabella and less divergent

preocular sutures. The pygidium is easily distinguished from that of the Moroccan species by its much wider (tr.) pleural lobes relative to the axis, a shorter postaxial field and a much more pronounced sculpture.

For a comparison of *C. latentissimus* n. sp. with similar taxa from the Eifel, see VAN VIERSEN (2007).

Cornuproetus sp. 2

(Pl. 11, Figs 9-11)

- v 2005 — *Cornuproetus* (*Cornuproetus*) *cornutus cornutus* (GOLDFUSS) – MAGREAN & VAN VIERSEN, p. 89, pl. 1, figs 1-7.
- ? 2007 — *Cornuproetus* (*Cornutus*) *cornutus* (GOLDFUSS) – MAGREAN, pp. 32, 33, pl. 1, figs 1-4.
- v 2008 — *Cornuproetus cornutus* ssp. 2 – VAN VIERSEN & PRESCHER, pp. 18, 19, fig. 4.

Material

One cranidium (IRSNB a12717), one external mould of a partial thoracopygidium plus silicone cast (IRSNB a12723); all from the Chavées Member of the Jemelle Formation at Jemelle (Loc004), Belgium.

Discussion

The cranidium from Jemelle resembles that of the type species of *Cornuproetus* from coeval strata in the Eifel but is distinct in having an anteriorly wider (tr.) glabella and the presence of a short (sag., exsag.) preglabellar field. The pygidial axial rings of the thoracopygidium from Jemelle are straightened (tr.) (instead of broadly M-shaped in *Cornuproetus cornutus*) and the pygidial border is uniformly broad.

MAGREAN (2007) recorded a complete *Cornuproetus* trilobite from the middle Eifelian in Couvin that he identified as *C. cornutus*. His specimen has the same anteriorly wide (tr.) glabella but the entire dorsal cuticle seems to be weathered so that it is difficult to make a detailed comparison.

Subfamily Dechenellinae PŘIBYL, 1946

Genus *Dechenella* KAYSER, 1880

Type species: Phillipsia verneuili BARRANDE, 1852 from the Givetian of the Eifel.

Dechenella rossumi n. sp.

(Figs 5A, 5B; Pl. 10, Figs 1-10; Pl. 11, Figs 1-6, 8)

Derivation of name

Named after Alfer van Rossum, who collected and kindly donated all of the type material.

Holotype

Enrolled specimen IRSNB a12777 (Figs 5A, 5B; Pl. 11, Figs 1-3, 8).

Type locality

Resteigne (Loc002), Belgium.

Type horizon

Upper part of Hanonet Formation.

Paratypes

Two cranidia (IRSNB a12732, a12774), one cranium and a pygidium on a single rock slab (IRSNB a12778), one external mould of a small (juvenile?) librigena (IRSNB a12779), one thorax segment (IRSNB a12780), one pygidium and a pygidium fragment on a single rock slab (IRSNB a12775), three pygidia on a single rock slab (IRSNB a12776); all from type locality and horizon.

Diagnosis

Large *Dechenella* species with small eyes that remain far from the lateral border furrows. Subocular groove is very broad. Lateral border furrow of cephalon is deep and broad. Pygidium is elongated, rounded subtriangular. Pygidial border slightly protrudes posteromedially.

Discussion

Dechenella rossumi n. sp. is similar to *Dechenella wotanica* from the Lower Givetian of the Eifel, but the latter is principally different in having more firmly impressed lateral glabellar furrows, posteriorly more quickly tapering pygidial pleural fields, and a pygidial border of uniform width posterolaterally to posteromedially. The librigena of *D. wotanica* is not known.

Dechenella daumeriesi from the lower part of the Hanonet Formation in Resteigne is contrasted as follows: larger eyes, a rudimentary subocular groove, a robust basis of the genal spine, a pygidial axis with medially anteriorly protruding rings that become fused towards the posterior end of the axis through the development of a "median bridge" (*sensu* BASSE, 2002), a wider pygidial outline and a pygidial border, which is broad medially to posterolaterally. Characteristic of *D. daumeriesi* is the weakly vaulted (tr.) pygidium with an evenly weakly vaulted (tr.) axis that hardly ascends above the pleural fields.

BASSE (1996) recorded a cranium and pygidium from the (according to its label) Givetian at "Fort Mont d'Haur" (sic) in Givet (northern France), which he assigned to *Dechenella* sp. B. The French species has

S1 firmly impressed and remaining at a clear distance from the axial furrow, broader (tr.) palpebral lobes, smaller lateral occipital lobes, a pygidial axis which has a particularly well-developed "median bridge" and which remains at a clear distance from the narrower posterior pygidial border and a much broader (tr.) pleural field anteriorly.

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Explanation of the plates

PLATE 1

Trilobites from the Kirberg Member of the Nohn Formation at Kirberg, Eifel, Germany.

Gerastos kippingi n. sp.

- Figs 1, 2, 6 – Holotype cranidium. IRSNB a12742. 1: lateral view, x 6.5; 2: dorsal view, x 6.5; 6: anterior view, x 6.5.
- Figs 3, 4, 7 – Cephalon together with a cranidium of *Cyphaspis unguoides unguoides* (ERBEN, 1953). IRSNB a12737. 3: dorsal view, x 4.0; 4: lateral view, x 4.0; 7: anterior view, x 4.0.
- Fig. 5 – Librigena. IRSNB a12739. Lateral view, x 4.0.
- Figs 8, 9, 11, 12 – Cephalon together with a librigena of *Dohmiella prescheri* VAN VIERSEN, 2006b. IRSNB a12736. 8: dorsal view, x 6.5; 9: lateral view, x 6.5; 11: oblique anterolateral view, x 6.5; 12: anterior view, x 6.5.
- Figs 10, 13, 14 – Large cranidium. IRSNB a12741. 10: anterior view, x 3.5; 13: dorsal view, x 3.5; 14: lateral view, x 3.5.
- Figs 15, 16 – Pygidium. IRSNB a12740. 15: dorsal view, x 5.5; 16: posterior view, x 5.5.
- Fig. 17 – Librigena. IRSNB a12743. Lateral view, x 10.0.
- Figs 18-20 – Pygidium. IRSNB a12738. 18: dorsal view, x 11.0; 19: posterior view, x 11.0; 20: lateral view, x 13.5.

PLATE 2

Trilobites from the Eilenberg Member of the Freilingen Formation at Rommersheim, Eifel, Germany.

Gerastos rommersheimensis n. sp.

- Figs 1-3 – Holotype cephalon. IRSNB a12752. 1: dorsal view, x 5.5; 2: lateral view, x 5.5; 3: anterior view, x 5.5.
- Figs 4, 5, 7 – Disarticulated specimen (notice the lateral tectonic deformation of the cephalon). IRSNB a12753. 4: dorsal view, x 4.0; 5: lateral view, x 4.0; 7: anterior view of cephalon, x 4.0.
- Fig. 6 – Cephalon. IRSNB a12754. Dorsal view, x 2.5.
- Figs 8-10, 12, 13 – Cephalon. IRSNB a12755. 8: oblique anterolateral view, x 2.5; 9: anterior view, x 2.5; 10: dorsal view, x 2.5; 12: left lateral view, x 2.5; 13: right lateral view, x 2.5.

Trilobites from the Jemelle Formation at Petigny, Ardennes, Belgium.

Gerastos arcus n. sp.

- Figs 11, 15, 16, 18 – Holotype partial cephalothorax. IRSNB a12781. 11: oblique anterolateral view, x 5.0; 15: dorsal view, x 5.0; 16: lateral view, x 5.0; 18: anterior view of cephalon, x 4.0.
- Figs 14, 17, 19 – Cephalon. IRSNB a12782. 14: lateral view, x 3.0; 17: dorsal view, x 3.0; 19: anterior view, x 3.0.

PLATE 3

Trilobites from the basal Hanonet Formation at Couvin, Ardennes, Belgium.

Gerastos couvinensis n. sp.

- Figs 1-6, 8 – Holotype complete specimen. NHMM 2009070. 1: dorsal view of thorax and pygidium, x 6.0; 2: lateral view, x 8.5; 3: lateral view of pygidium, x 19.0; 4: anterior view of cephalon, x 10.0; 5: dorsal view of cephalon, x 7.5; 6: posterior view of pygidium, x 10.0; 8: oblique anterolateral view, x 7.5.
- Figs 7, 9, 11, 12 – Cranidium. IRSNB a12725. 7: anterior view, x 8.0; 9: lateral view, x 8.0; 11: oblique anterolateral view, x 8.0; 12: dorsal view, x 8.0.
- Fig. 10 – Small librigena. IRSNB a12719. Lateral view, x 14.0.
- Fig. 13 – Librigena (lacking upper part). IRSNB a12720. Lateral view, x 12.0.

PLATE 4

Trilobites from the Eilenberg Member of the Freilingen Formation at Rommersheim, Eifel, Germany.

Gerastos batrachus n. sp.

- Figs 1-3, 7 – Holotype cephalon. IRSNB a12744. 1: oblique anterolateral view, x 9.0; 2: anterior view, x 6.0; 3: dorsal view, x 6.0; 7: lateral view, x 6.0.
 Figs 4-6 – Cranidium. IRSNB a12747. 4: lateral view, x 5.0; 5: anterior view, x 5.0; 6: dorsal view, x 5.0.
 Figs 8-10, 13 – Cephalon. IRSNB a12745. 8: dorsal view, x 6.0; 9: anterior view, x 6.0; 10: oblique anterolateral view, x 6.0; 13: lateral view, x 6.0.
 Figs 11, 14, 17 – Pygidium. IRSNB a12746. 11: dorsal view, x 9.0; 14: posterior view, x 9.0; 17: lateral view, x 9.0.
 Fig. 16 – Cephalon. IRSNB a12748. Anterior view, x 5.5.

Gerastos rommersheimensis n. sp.

- Figs 12, 15, 18 – Pygidium. IRSNB a12751. 12: dorsal view, x 10.0; 15: posterior view, x 10.0; 18: lateral view, x 10.0.

PLATE 5

Trilobite from the upper part of the Hanonet Formation at Wellin, Ardennes, Belgium.

Gerastos snellingsi n. sp.

- Figs 1-8 – Holotype complete specimen. NHMM 2009069. 1: dorsal view of thorax and pygidium, x 4.0; 2: lateral view, x 4.0; 3: oblique lateral view, x 4.0; 4: dorsal view of cephalon, x 4.5; 5: posterior view of pygidium, x 6.0; 6: oblique anterolateral view, x 4.0; 7: anterior view of cephalon, x 4.5; 8: oblique posterolateral view, x 4.0.

PLATE 6

Trilobites from the Köll Member of the Ahrdorf Formation at Gerolstein, Eifel, Germany.

Dohmiella acanthonota n. sp.

- Figs 1-3 – Cranidium. IRSNB a12764. 1: dorsal view, x 7.5; 2: anterior view, x 7.5; 3: lateral view, x 7.5.
 Figs 4, 7, 10 – Small (juvenile?) cranidium. IRSNB a12765. 4: dorsal view, x 10.0; 7: anterior view, x 10.0; 10: lateral view, x 10.0.
 Figs 5, 6, 8, 9 – Holotype pygidium. IRSNB a12766. 5: posterior view, x 10.0; 6: lateral view, x 10.0; 8: dorsal view, x 10.0; 9: oblique posterolateral view, x 10.0.
 Figs 11, 12, 15 – Pygidium. IRSNB a12767. 10: dorsal view, x 10.0; 11: oblique posterolateral view, x 10.0; 14: lateral view, x 10.0.
 Figs 13, 16 – Pygidium. IRSNB a12768. 12: dorsal view, x 9.0; 15: posterior view, x 9.0.
 Fig. 14 – Librigena. IRSNB a12769. Lateral view, x 7.5.

PLATE 7

Trilobites from the Köll Member of the Ahrdorf Formation at Gerolstein, Eifel, Germany.

Dohmiella acanthonota n. sp.

- Figs 1, 4 – Incomplete specimen. IRSNB a12770. 1: lateral view, x 14.0; 4: dorsal view of pygidium, x 7.0.
 Fig. 2 – Librigena, together with fragment of a scutelline pygidium (unfigured). IRSNB a12771. Lateral view, x 10.0.
 Figs 3, 5 – Pygidium. IRSNB a12772. 3: posterior view, x 10.0; 5: lateral view, x 10.0.

Trilobites from the basal Hanonet Formation at Couvin, Ardennes, Belgium.

Astycoryphe exilis n. sp.

- Figs 6, 8, 9, 12 – Holotype cranidium. IRSNB a12729. 6: oblique anterolateral view, x 20.0; 8: anterior view, x 20.0; 9: dorsal view, x 20.0; 12: oblique lateral view, x 20.0.
 Figs 7, 10, 13 – Librigena. IRSNB a12734. 7: anterior view, x 20.0; 10: dorsal view, x 20.0; 13: lateral view, x 20.0.
 Fig. 11 – External mould of a fragmentary cranidium (digitally inverted image). IRSNB a12722. Dorsal view, x 20.0.

PLATE 8

Trilobites from the basal Hanonet Formation at Resteigne, Ardennes, Belgium.

Astycoryphe jorusi n. sp.

- Figs 1, 3 – Librigena with an external mould of a partial librigena next to it (unfigured). IRSNB a12758. 1: anterior view, x 17.0; 3: dorsal view, x 17.0.
 Figs 2, 5, 12, 13 – Cranidium. IRSNB a12759. 2: anterior view, x 14.0; 5: dorsal view, x 14.0; 12: oblique anterolateral view, x 14.0; 13: oblique lateral view, x 14.0.
 Fig. 4 – Librigena. IRSNB a12760. Dorsal view, x 14.0.
 Fig. 6 – Librigena. IRSNB a12762. Dorsal view, x 14.0.
 Figs 7, 10 – Holotype pygidium. IRSNB a12761. 7: dorsal view, x 14.0; 10: posterior view, x 14.0.
 Fig. 8 – Cranidium fragment. IRSNB a12763. Dorsal view, x 10.0.
 Figs 9, 11 – Juvenile pygidium. IRSNB a12757. 9: dorsal view, x 20.0; 11: posterior view, x 20.0.

PLATE 9

Trilobites from the basal Hanonet Formation at Couvin, Ardennes, Belgium.

Cornuproetus latentissimus n. sp.

- Figs 1, 3, 6 – Holotype cranidium. IRSNB a12726. 1: oblique anterolateral view, x 11.0; 3: dorsal view, x 11.0; 6: anterior view, x 11.0.
 Fig. 2 – Thorax segment. IRSNB a12727. Dorsal view, x 10.0.
 Fig. 8 – Librigena. IRSNB a12447. Dorsal view, x 10.0.
 Figs 9-11 – Pygidium together with an unfigured partial cranidium of *Dechenella* sp. IRSNB a12724. 9: posterior view, x 14.0; 10: dorsal view of external mould (digitally inverted image), x 14.0; 11: dorsal view, x 14.0.

Trilobite from the basal Hanonet Formation at Resteigne, Ardennes, Belgium.

Cornuproetus cf. *latentissimus* n. sp.

- Figs 4, 5, 7 – Cranidium. IRSNB a12731. 4: dorsal view, x 6.0; 5: lateral view, x 6.0; 7: anterior view, x 6.0.

PLATE 10

Trilobites from the upper part of the Hanonet Formation at Resteigne, Ardennes, Belgium.

Dechenella rossumi n. sp.

- Figs 1, 4 – Incomplete cranidium. IRSNB a12732. 1: dorsal view, x 5.0; 4: lateral view, x 5.0.
 Figs 2, 3, 5 – Cranidium. IRSNB a12774. 2: dorsal view, x 6.5; 3: lateral view, x 6.5; 5: anterior view, x 6.5.
 Figs 6, 9, 10 – Pygidium, together with a pygidium fragment (not figured). IRSNB a12775. 6: lateral view, x 3.5; 9: oblique posterior view, x 3.5; 10: dorsal view, x 3.5.

- Fig. 7 – Three pygidia on a single rock slab. IRSNB a12776. a: oblique dorsal view of pygidium showing anomalous pleurae; b: lateral view of juvenile pygidium; c: lateral view of pygidium, x 6.0.
- Fig. 8 – Three pygidia on a single rock slab. IRSNB a12776. a: oblique dorsal view of pygidium showing anomalous pleurae; b: dorsal view of juvenile pygidium; c: dorsal view of pygidium, x 6.0.

PLATE 11

Trilobites from the upper part of the Hanonet Formation at Resteigne, Ardennes, Belgium.

Dechenella rossumi n. sp.

- Figs 1-3, 8 – Holotype enrolled specimen. IRSNB a12777. 1: dorsal view of cephalon, x 3.5; 2: lateral view, x 3.5; 3: anterior view, x 2.5; 8: dorsal view of mostly exfoliated pygidium, x 2.5.
- Figs 4, 6 – Cranidium. IRSNB a12732. 4: dorsal view, x 7.0; 6: anterior view, x 7.0.
- Fig. 5 – External mould of a small (juvenile?) librigena (digitally inverted image). IRSNB a12779. Dorsal view, x 10.0.

Trilobite from the Foulerie Member of the Couvin Formation at Nismes, Ardennes, Belgium.

Astycoryphe sp. B

- Fig. 7 – Librigena, together with a partial external mould of a second librigena (not figured). IRSNB a12718. Dorsal view, x 8.0.

Trilobites from the Chavées Member of the Jemelle Formation at Jemelle, Ardennes, Belgium.

Cornuproetus sp. 2

- Fig. 9 – Silicone cast of a partial thoracopygidium. IRSNB a12723. Dorsal view, x 5.0.
- Figs 10, 11 – Cranidium. IRSNB a12717. 10: anterior view, x 8.0; 11: dorsal view, x 8.0.

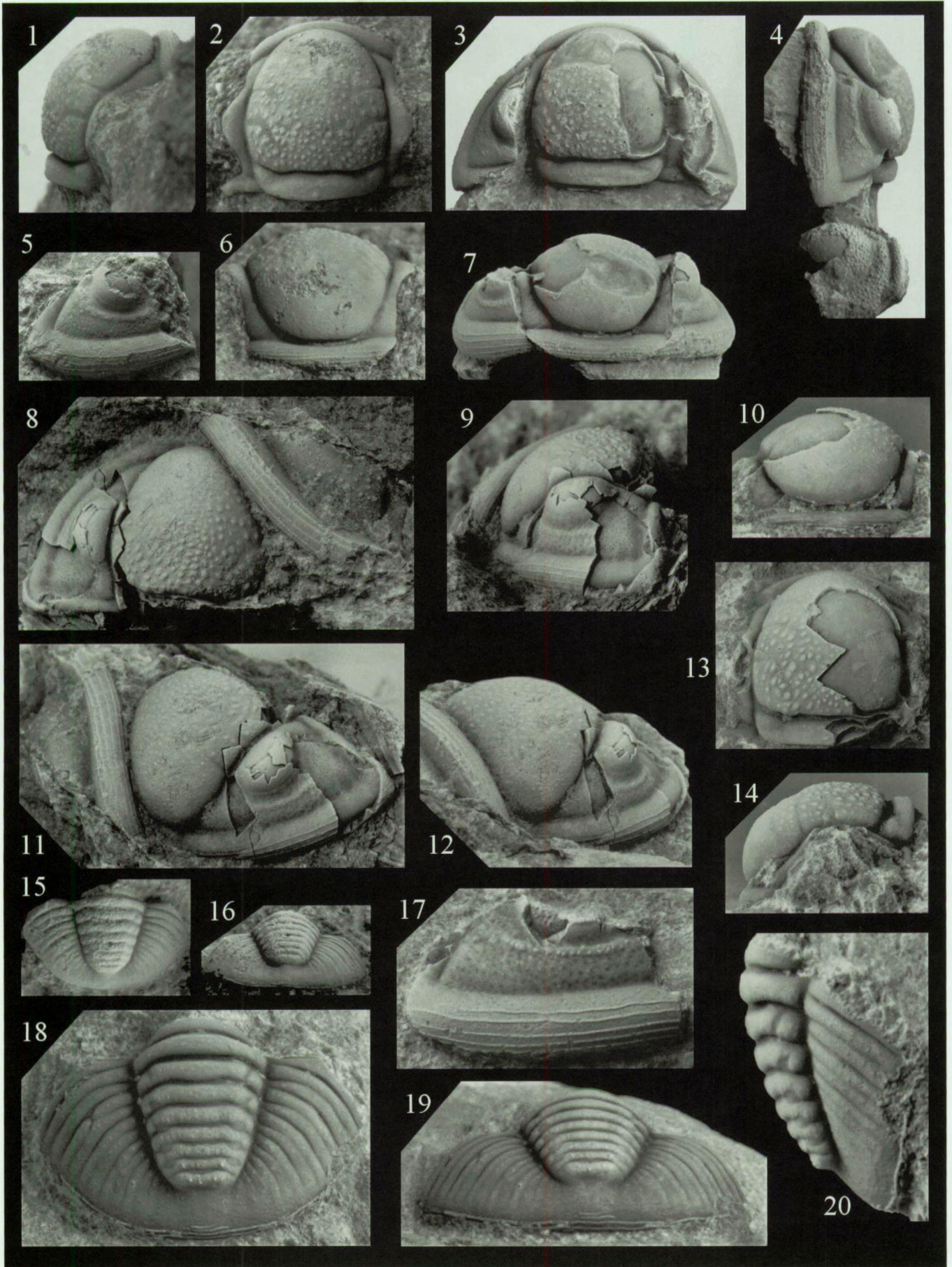


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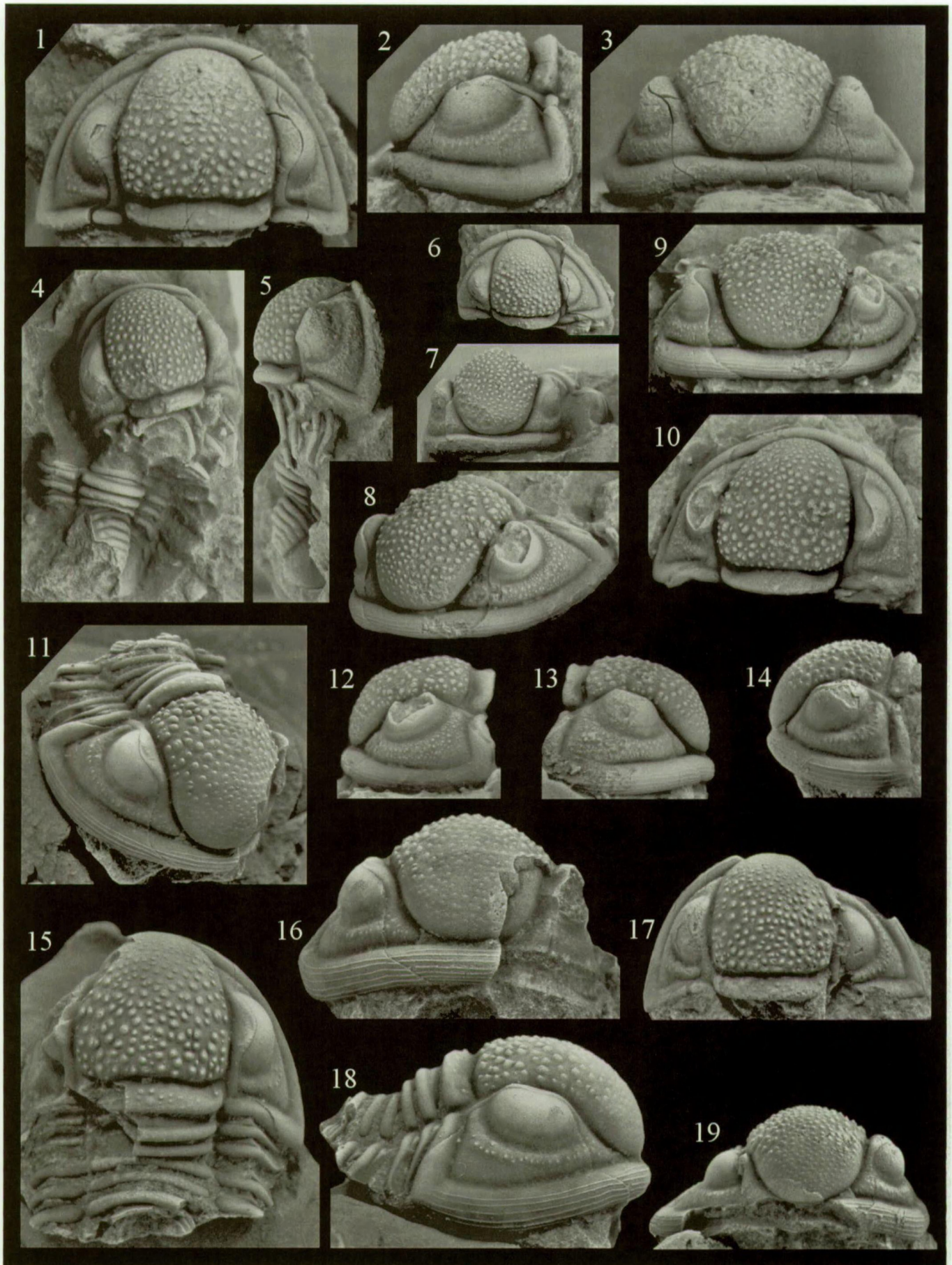


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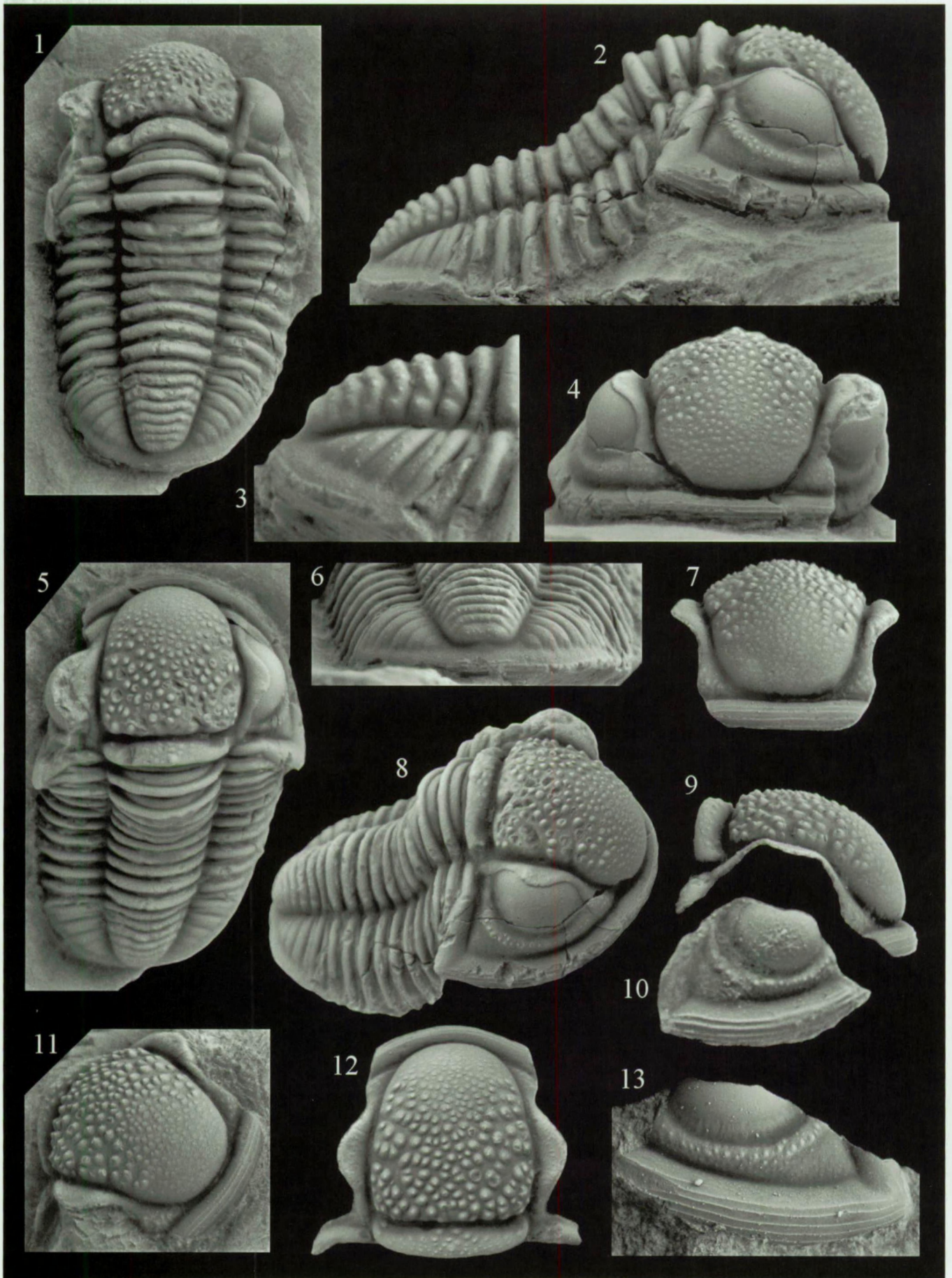


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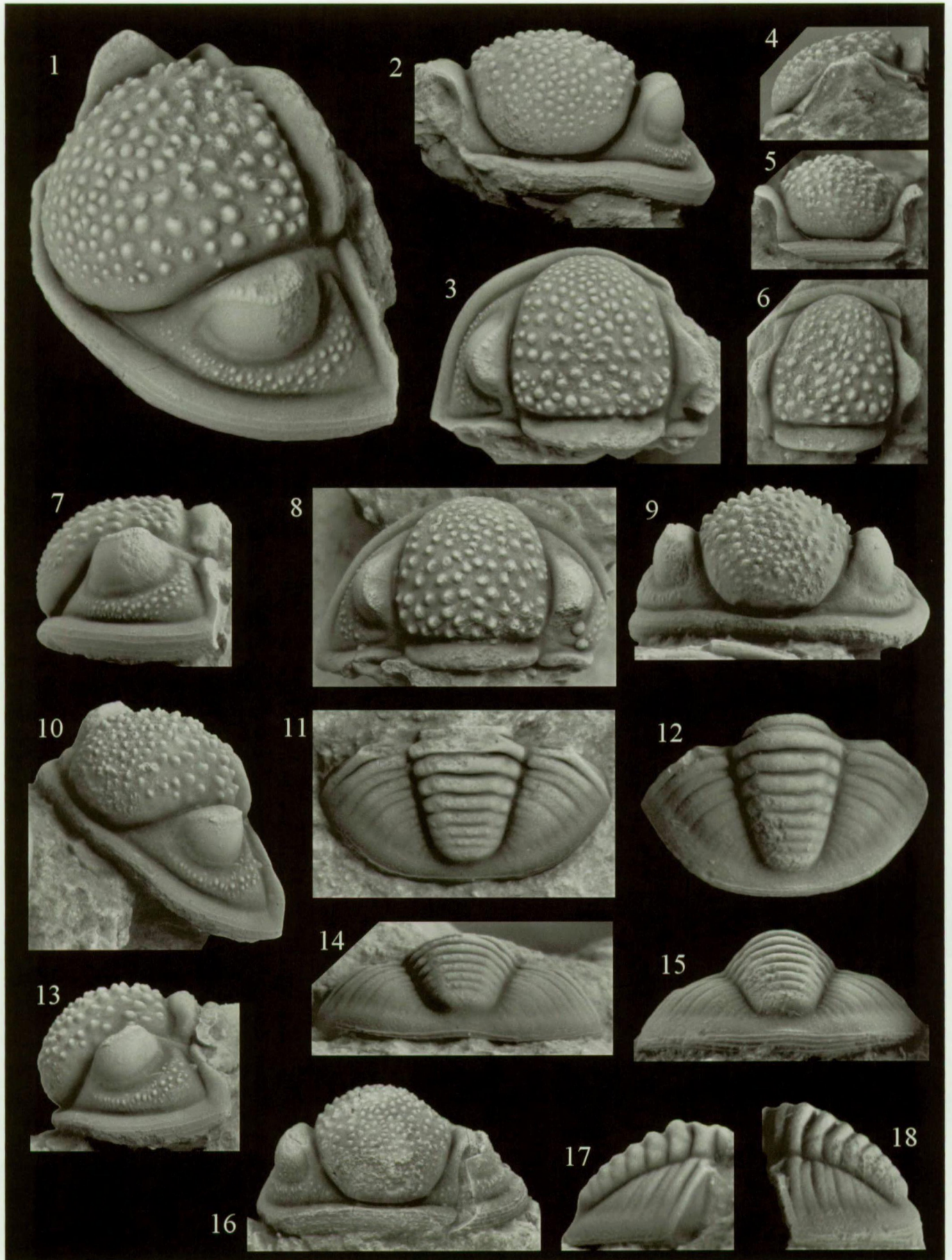


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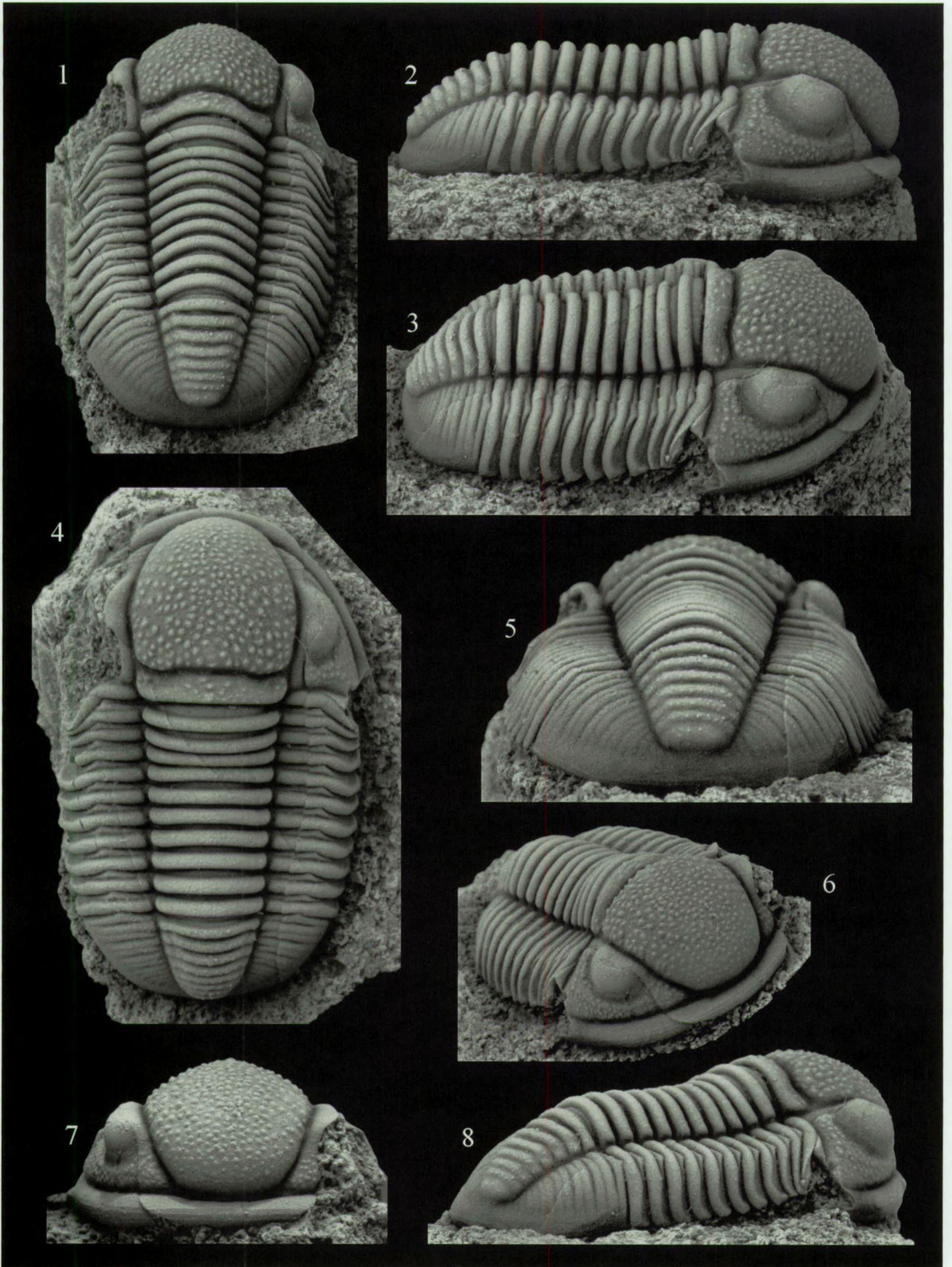


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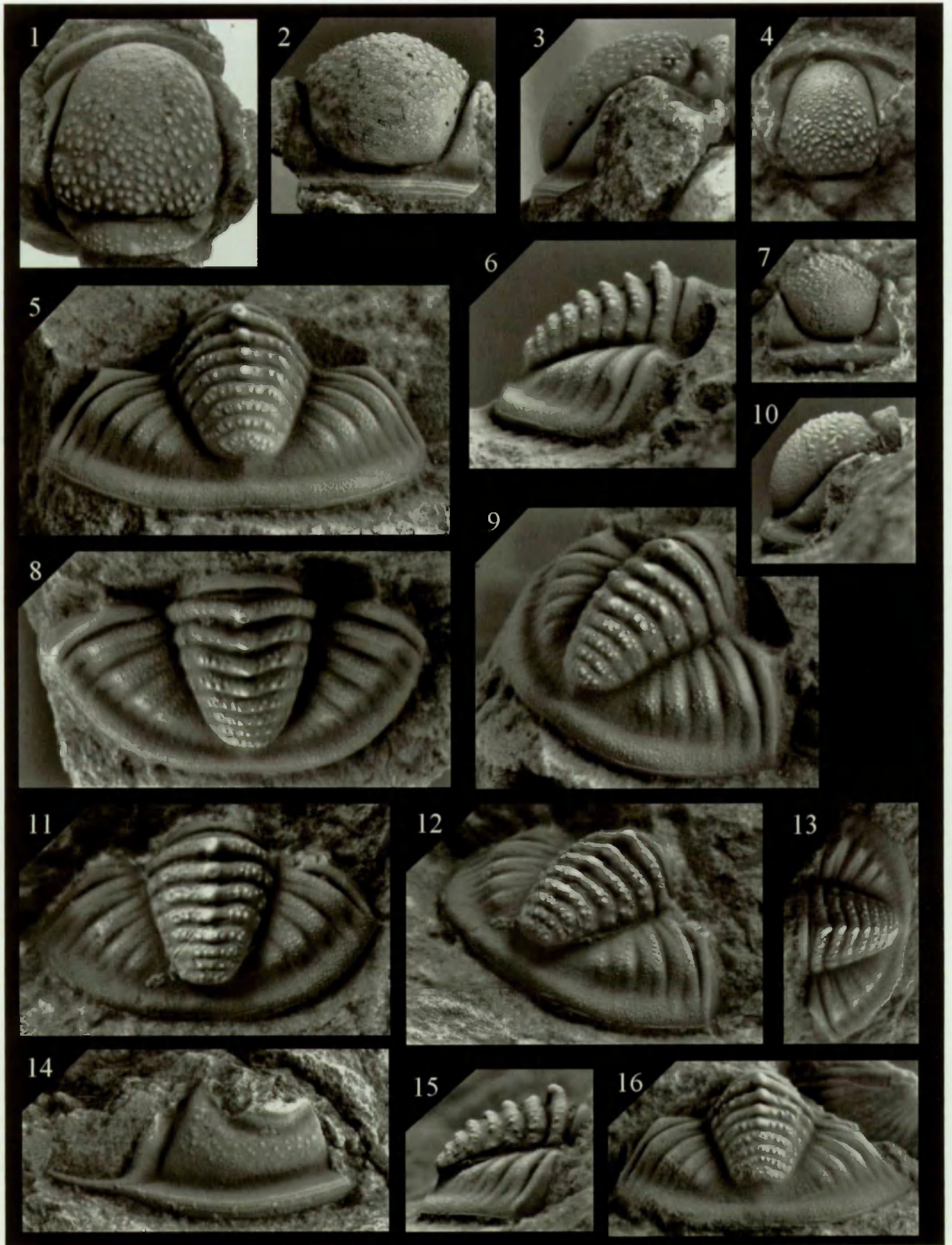


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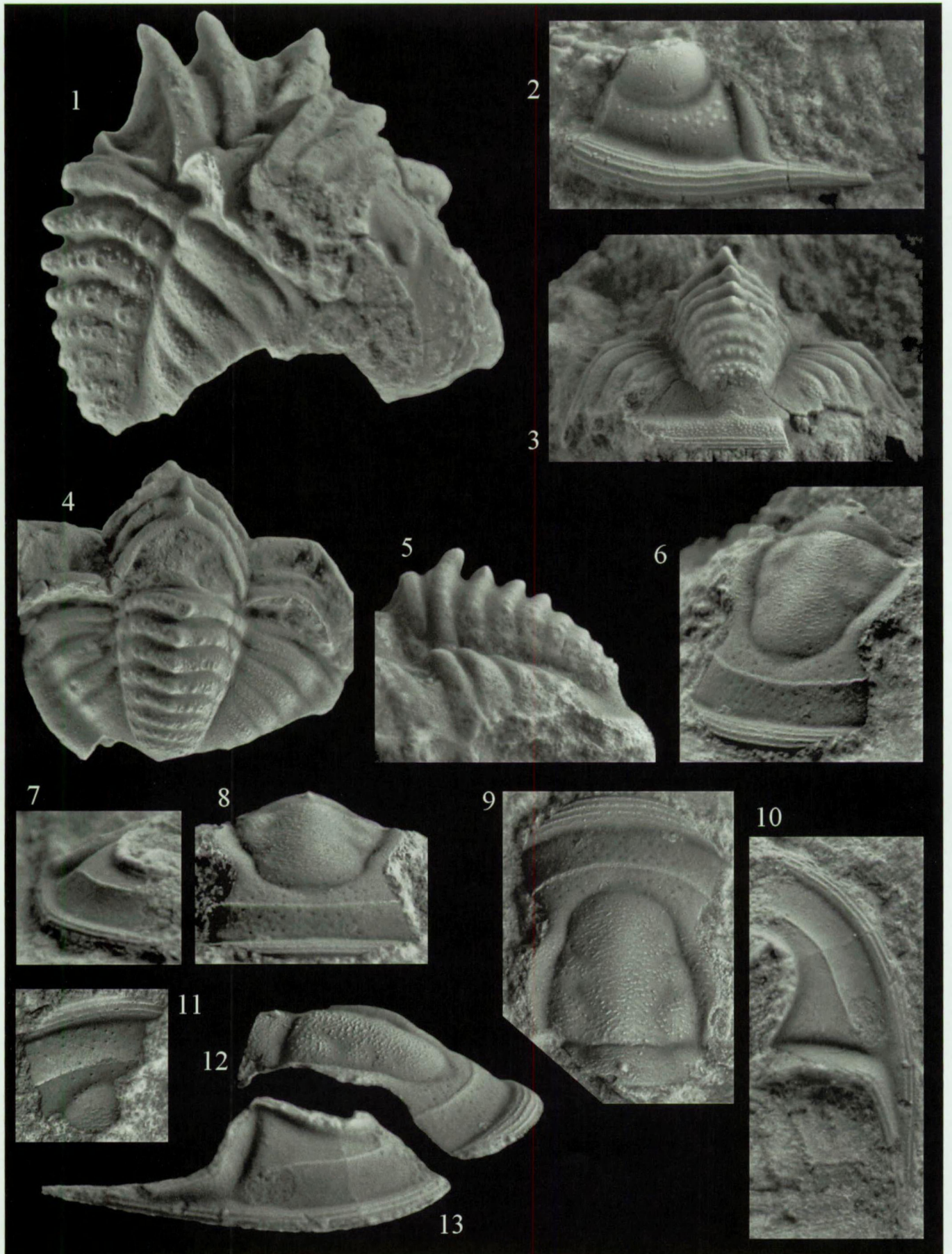


PLATE 7



PLATE 8

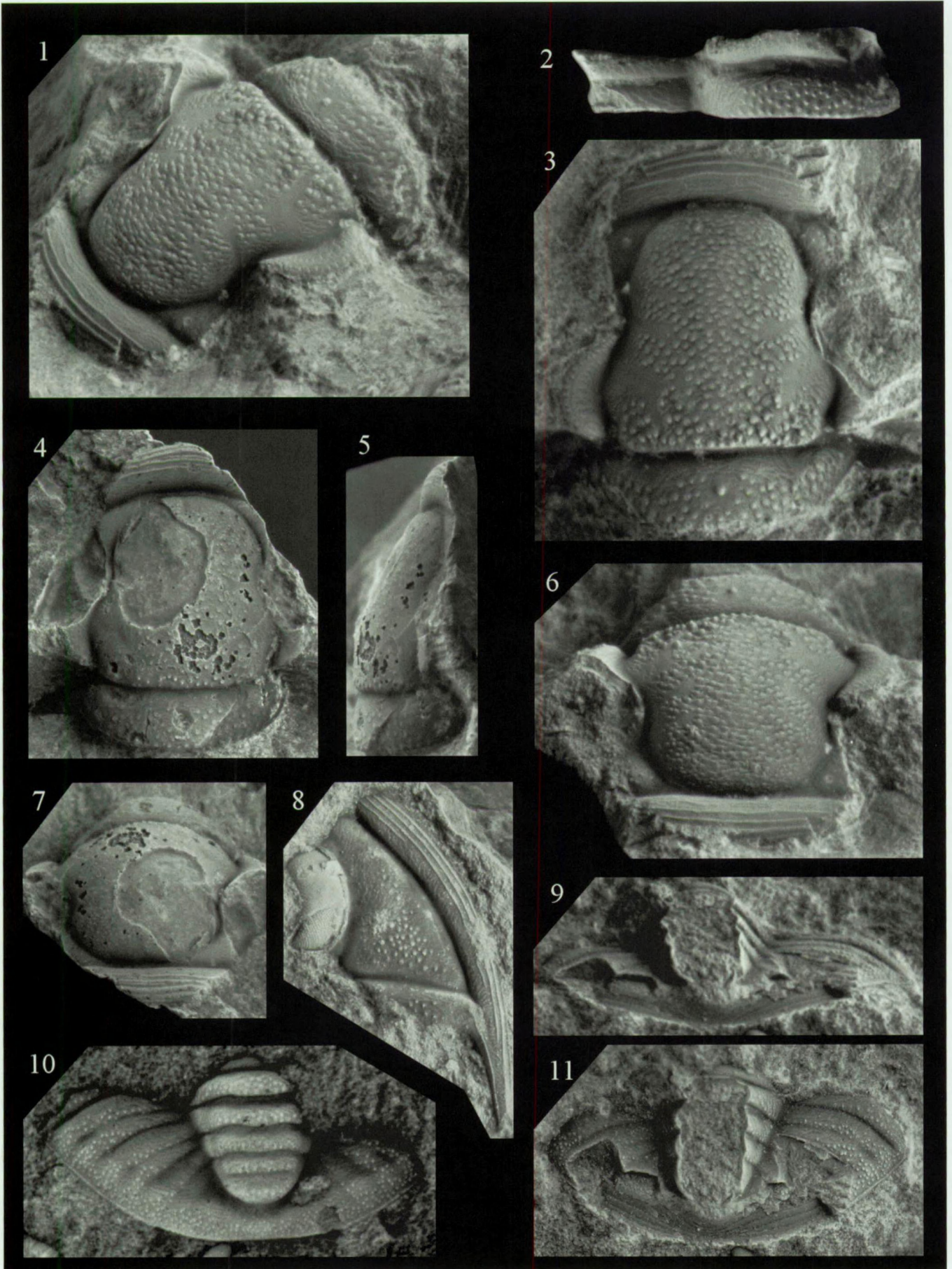


PLATE 9

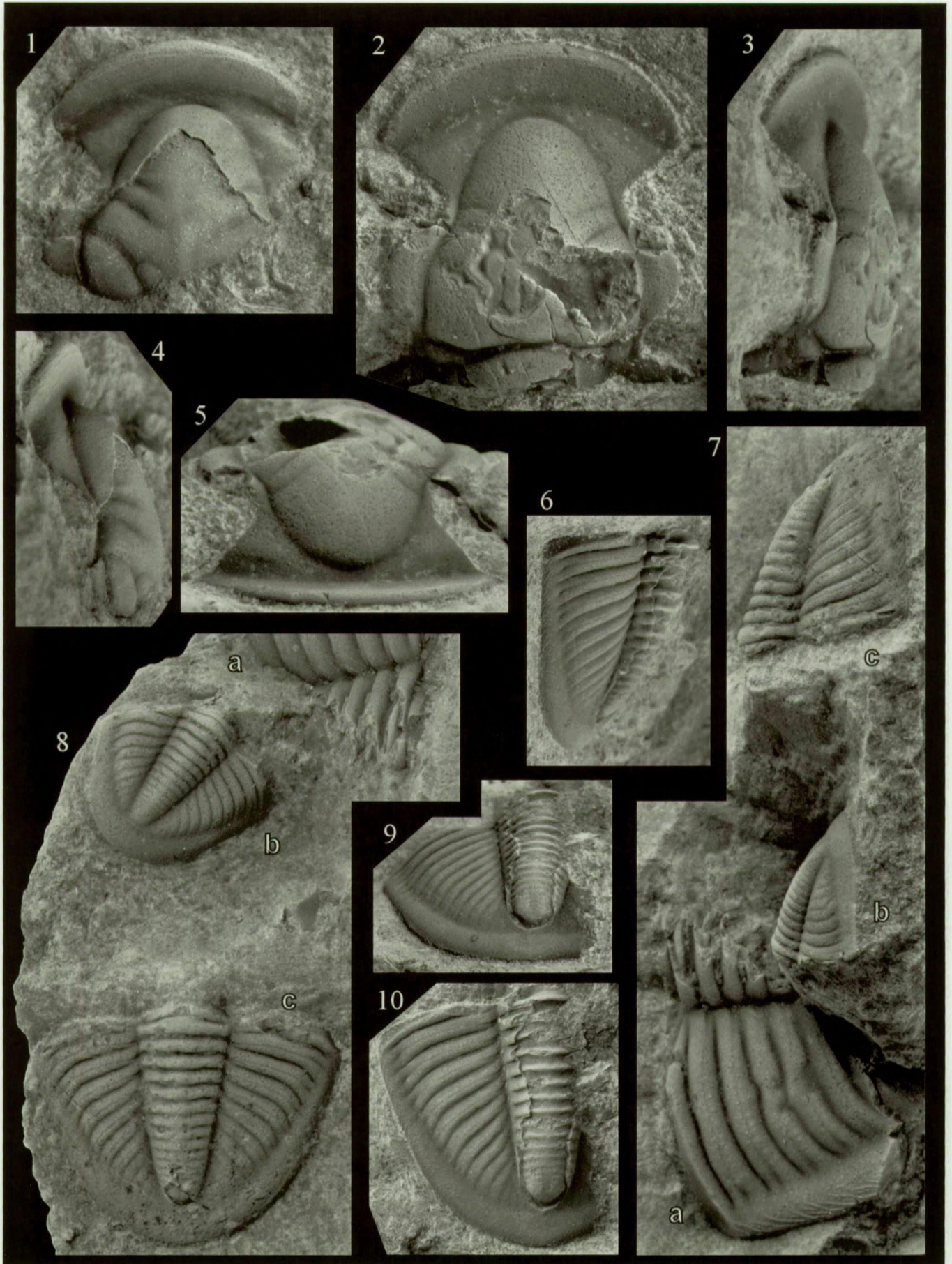


PLATE 10

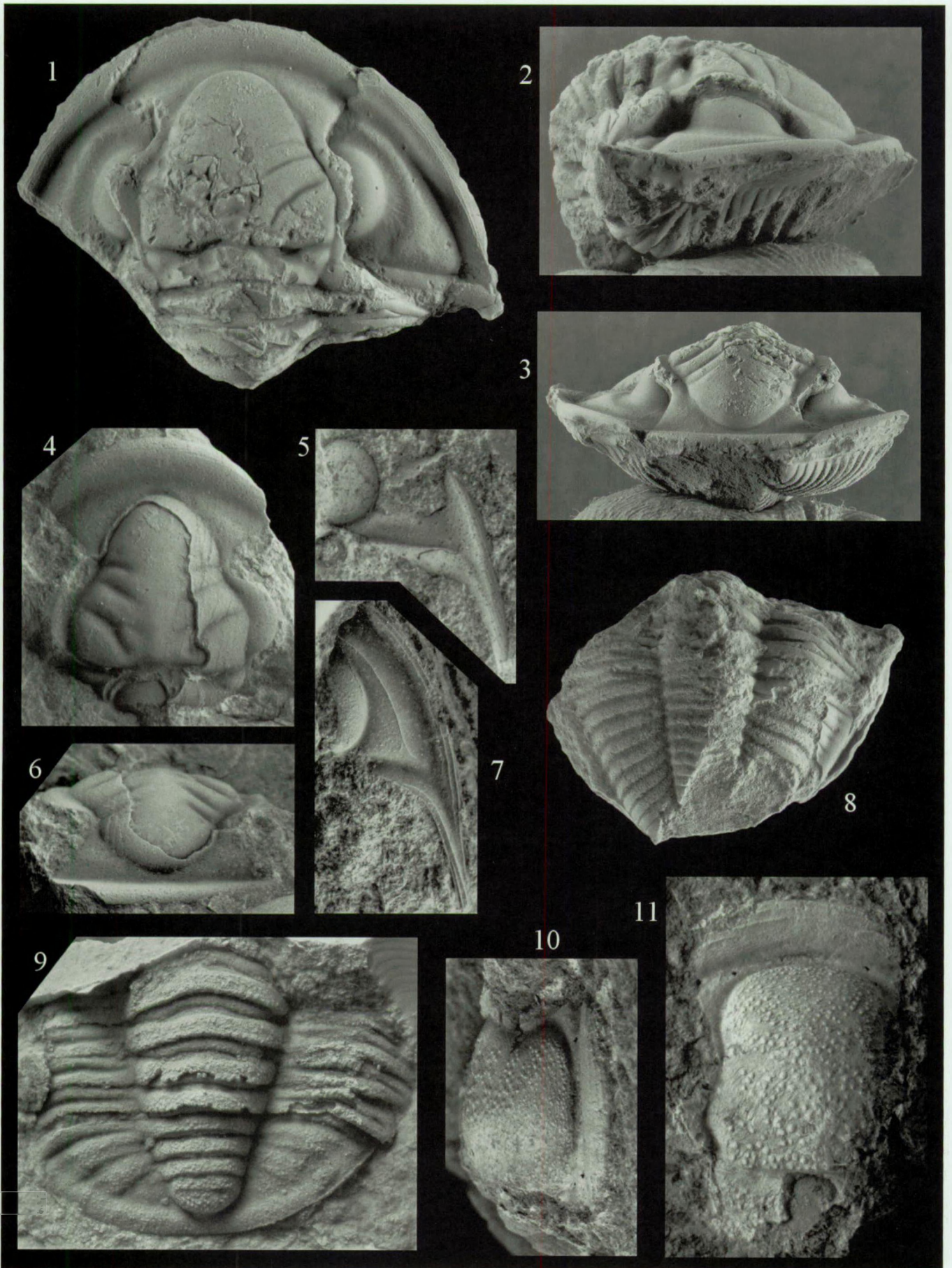


PLATE 11

