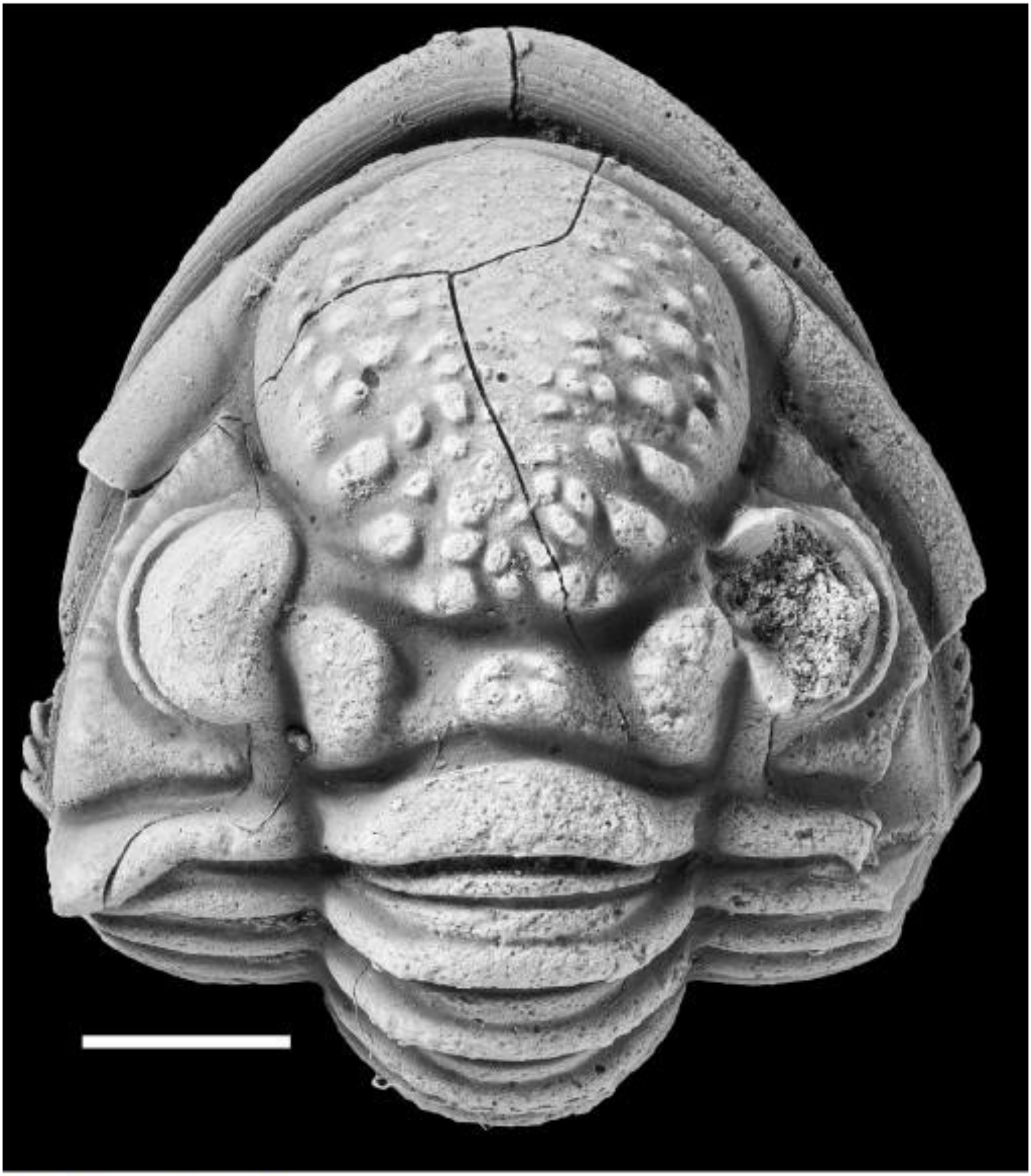
THE TRILOBITE PAPERS 22



An international
newsletter for and by
trilobite paleontologists
August 2019

Dedicated to Rolf Ludvigsen

The Trilobite Papers Twenty-Two
August 2019

Editorial:

INTO THE CANYON OF TIME

Re-exploring classic localities and concepts can be vital in reshaping our present views or verifying the classic concepts. I recently was given the opportunity visit and collect one such locality—the Grand Canyon. The research trip was organized by Karl Karlstrom from the University of New Mexico and involved 14 days of a rafting trip down the Grand Canyon. One of the goals of the trip was to re-investigate the Cambrian of the Grand Canyon, which included collecting fossil localities in the Tonto Group (we had National Park Service collecting permits). This was the first time in over 70 years that Cambrian fossils have been collected, since Edwin McKee.

Why is this important? Besides the reinvestigation of Charles Resser's trilobite locations and taxonomy, the Grand Canyon has been a classic model of a transgressive package used in several geology/earth science textbooks. The model suggests that the Tapeats Sandstone is a diachronous transgressive sandstone (beach), migrating from west to east, followed by the Bright Angel Shale (off shore, marine), and then the Mauv Limestone (carbonate bank) progressing to eventually cover this portion of the craton.

Of course the original model proposed by McKee and Resser in 1945 was more complex with a transition zone between the Tapeats and Bright Angel and extensive intertongueing of the Bright Angel and Mauv. Work by Eben Rose has also shown that the stratigraphic relationships are more complicated. Being able to collect the old and new trilobite localities and the dating of detrital zircons allows us to test these models. One of the preliminary findings is the base of the Bright Angel is diachronous, with *Glossopleura* faunas found in the eastern Grand Canyon and *Olenellus* faunas found in the west. However, the radiometric dating of detrital zircons, which provides a maximum depositional age (work done by Mark Schmitz and his student Michael Mohr at Boise State University) provides some breakthroughs: 1) the Sixtymile Formation below the Tapeats Sandstone is Cambrian, not Precambrian as previously assumed; 2) The transgression of the Cambrian environments did not occur in 40 -60 million years, but only in about 10 million years; and 3) the extinction of *Olenellus* occurred after 506.5 million years ago, long after

the appearance of *Paradoxides* in Europe.
Sincerely trilobitic,

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Cover photo: The Permian trilobite *Hentigia ornata* Fortey and Heward, 2014 from the Qarari Unit, Batain Group, Oman. Scale bar 2.5 mm. Photo provided by Richard Fortey.

RESEARCH REPORTS

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My work concentrates on the reconstruction of early and middle Cambrian earth history illustrated by rocks from different regions of this planet. Trilobites play a key role in these research activities, and I appreciate to do not only systematic descriptions, but particularly to unravel erroneous assumption of morphological details and revise information on the taxonomy and biostratigraphy of trilobites.

After finishing a taxonomic study on the earliest trilobites from Morocco (reference below), I am continuing with the phylogenetic consequences and its impact on the Cambrian Series 2 lower boundary. Further research activities include the study of para-/neoredlichiids and despujolsiids (the *Resserops* clade) from the lower Cambrian of Morocco; the taxonomy of solenopleurids in general; the biostratigraphy and taxonomy of trilobites from the *Ornamentaspis frequens* through *Badulesia tenera* zones in Morocco; a monograph of the trilobites from the Wildenstein Member of the Tannenknock Formation in the Franconian Forest, Germany; newly discovered trilobite assemblages from the late Wuliuan and early Drumian from the Franconian Forest, Germany; ptychoparioids from Peary Land, Greenland; lower Cambrian trilobites from the eastern High Atlas (Morocco/Algeria) and their meaning for the depositional development and paleogeography of the northwestern Africa segments during the Cambrian; and others.

Geyer, G., 2019. The earliest known West Gondwanan trilobites from the Anti-Atlas of Morocco, with a revision of the Family Bigotinidae Hupé, 1953. Fossils & Strata.

Geyer, G., Nowicki, J., Żylińska, A., and Landing, E. 2019. Comment on: Álvaro, J. J., Esteve, J. & Zamora, S. 2019. Morphological assessment of the earliest paradoxidid trilobites (Cambrian Series 3) from Morocco and Spain [Geological Magazine]. Geological Magazine, https://doi.org/10.1017/S0016756818000961.

Geyer, G., Landing, E., Höhn, S., Linnemann, U., Meier, S., Servais, T., Wotte, T. & Herbig, H.-G. 2019. Revised Cambrian stratigraphy in the Franconian Forest (Frankenwald), Germany, reveals typical West Gondwana succession in the Saxothuringian Belt. Newsletters on Stratigraphy, https:/doi.org/10.1127/nos/2019/0495.

Cederström, P., Geyer, G., Ahlberg, P., Nilsson, C. A. & Ahlgren, J., under review. Ellipsocephalid trilobites from Cambrian Series 2 and Stage 4 in Scania, Sweden: taxonomy, morphological plasticity and biostratigraphic significance. Fossils & Strata.

Geyer, Pais, M. and Wotte, T. Submitted. Wrongly curved spines in a Cambrian trilobite? Considerations on the spinosity in *Kingaspidoides spinirecurvatus* n. sp. from the Anti-Atlas, Morocco, and related Cambrian ellipsocephaloids. PalZ.

JOHN LAURIE
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I am involved in the following projects: southernmost Tasmanian late Furongian agnostid and trilobite faunas (with Jim Jago and Kim Bischoff); the agnostid and trilobite faunas from a fully cored petroleum well (Hunt 1) which penetrates the lowermost Cambrian Stage 5 in the Georgina Basin of central Australia; trilobite and agnostid faunas from Trilobite Rock, New Zealand (with Jim Jago, Pat Smith and Roger Cooper).

ALAN OWEN, School of Geographical and Earth Sciences, University of Glasgow, Gregory Building, Lilybank Gardens, Glasgow G12 8QQ, Scotland, U.K.
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With the editing of the *Fossils and Strata* trilobite volume finally out of the way, I have been able to devote time to some of the projects noted in TTP20. In particular, good progress is being made on the description of the trilobites faunas of the upper Katian Slade and Redhill Formation in South Wales with Lucy McCobb (National Museum of Wales, Cardiff) and Patrick McDermott (St Clears, South Wales) and, with Keith Ingham (Hunterian Museum, Glasgow), on deep water trilobites from the Hirnantian in the Ordovician-Silurian boundary stratotype section at Dob's Linn and elsewhere in the Scottish Southern Uplands. There is little to report on my work on trilobite faunas from Ireland – but they have not been forgotten, nor has my long-intended analysis of deep water Ordovician faunas.

McCobb, L.M.E., McDermott, P.D. & Owen, A.W. 2019: The taphonomy of a trilobite fauna from an uppermost Katian echinoderm Lagerstätte in South West Wales. *Fossils and Strata 64*, 193-203.
Owen, A.W. & Bruton, D.L. (eds) 2019: Papers from the 6th international Conference on Trilobites and their Relatives. *Fossils and Strata 64*, 1-232.
Owen, A.W. & Bruton, D.L. 2019: Papers from the 6th international Conference on Trilobites and their Relatives. *Fossils and Strata 64*, 1-3.

FRED SUNDBERG, Research Associate, Museum of Northern Arizona, Flagstaff, AZ <freddeb85@cableone.net>

It has been a busy year. I have four manuscripts that have been submitted and/or just about ready to submit. These papers include a morphometic analysis of *Oryctocephalites palmeri* (JP—reviewed, with Mark Webster as lead author), redefinition of the Tonto Group of the Grand Canyon (Geology—submitted, with Karl Karlstrom as lead author), the recognition of overlap between olenellids and paradoxides (Geology—nearly ready to be submitted), and the trilobites from the Lakeview Limestone, Idaho (JP—just about ready to be submitted). Once these projects are off, then I will be working on the trilobites collected from the Grand Canyon (see editorial); how much morphological change results in compaction of specimens in shale (morphometric study using landmarks); *Ovatoryctocara* and fauna from the Harkless Formation (lower Cambrian, Fig. 1); and a morphometric study of the small eyed ptychopariid trilobites (e.g., *Elrathina*).

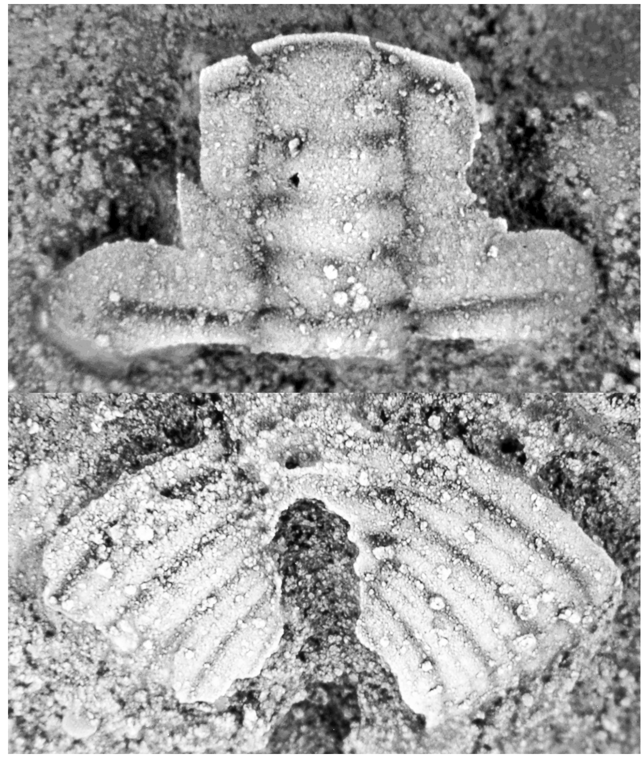

Figure 1. Ovatoryctocara sp. from the lower Cambrian (Series 2, Stage 4) Harkless Formation, Clayton Ridge, Nevada. Cranidial length 1.2 mm; pygidial length 2.0mm

PAPERS FROM THE 6TH INTERNATIONAL CONFERENCE ON TRILOBITES AND THEIR RELATIVES. *FOSSILS AND STRATA 64*, 1-232.

Alan Owen, University of Glasgow, Scotland, U.K. <alan.owen@glasgow.ac.uk>

The volume of *Fossils and Strata* containing a set of papers arising from the 2017 trilobite meeting in Tallinn has now been published. The volume which I edited with David Bruton includes a report of the Tallinn conference by its organiser, Helje Pärnaste, and a review of the meetings that preceded it by David Bruton. The papers in the volume range from systematic descriptions of taxa to aspects of ontogeny, biofacies, biostratigraphy and taphonomy and together they encompass trilobites from the Early Cambrian to the Late Devonian. The list of contents is as follows:

Owen, A.W. & Bruton, D.L. 2019: Papers from the 6th

international Conference on Trilobites and their Relatives. *Fossils and Strata 64*, 1-3.
Bruton, D.L. 2019: From Oslo to Prague – the Trilobite Meetings 1973 – 2012. *Fossils and Strata 64*, 5-16.
Pärnaste, H. 2019: The 6th International Conference on Trilobites and their Relatives: Tallinn calling, Estonia celebrating. *Fossils and Strata 64*, 17-22.
Bernárdez, E., Esteve, J., Laibl, L., Rábano, I. & Gutiérrez-Marco, J.C. 2019: Early post-embryonic trilobite stages and possible eggs from the 'Túnel Ordovícico del Fabar' (Middle Ordovician, northwestern Spain). *Fossils and Strata 64*, 23-33.
Ebbestad, J.O.R. & Fortey, R.A. 2019: Stratigraphy and trilobite biofacies of the Late Ordovician of the Taimyr Peninsula, Arctic Russia. *Fossils and Strata 64*, 35-53.
Geyer, G. 2019: The earliest known West Gondwanan trilobites from the Anti-Atlas of Morocco, with a revision of the Family Bigotinidae Hupé, 1953. *Fossils and Strata 64*, 55-153.

FIELD NOTES

Cirquella n. sp. of lower Montenegro Member, Nevada: A preliminary report

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Recent collecting in Esmeralda County, Nevada has uncovered material of an apparent new species assignable to the Montezuman (Early Cambrian, Stage 3) trilobite genus *Cirquella*. This includes the first articulated material known for the genus.

This new trilobite and horizon was discovered by Perry and Maria Damiani in the Montezuma Range in 2019. The collection horizon is low in the Montenegro Member of the Campito Formation; although stratigraphic work on the collection is not yet completed, a preliminary estimate is 157 meters above the base of the Montenegro Member. The associated fauna includes *Montezumaspis* sp. (or spp.? - possibly both *M. cometes* (Fritz) and *M. parallela* (Fritz)) and a small *Nevadia*? aff. *Nevadella effusa* Repina (see Bushuev et al 2014, fig. 11D), a form of potential interest for Laurentia -Siberia correlation. *Cirquella* n. sp. appears to be an uncommon element of the fauna. Another collection a few meters higher contained a similar fauna but not yielding *Cirquella*. Similarity is noted with the fauna from Hollingsworth's "MN-f 163" collection (Hollingsworth 2006, fig. 4; Hollingsworth 2011, fig. 5).

The placement of the new collection, according to current usage, is therefore very low in the *Esmeraldina rowei* Biozone of Hollingsworth 2011, although it appears to be some distance below the FAD of the eponymous species of that zone. Earlier, Hollingsworth (2008a) had proposed a 26 meter-thick *Montezumaspis parallela* Biozone (to underlie the *E. rowei* Biozone), which was abandoned in the 2011 paper; the current locality would doubtless fall within the *M. parallela* Biozone, were it to be separately recognized. We plan to elucidate these relationships with further fieldwork.

Three previously described species have been assigned to *Cirquella* – *C. nummularia* and *C. espinata* from Canada (Fritz 1993) and *C. nelsoni* (Lieberman) from California (Lieberman 2001). The two Canadian species (or closely similar forms) have also been reported in Nevada (Fritz 1993; Hollingsworth 2011), both in a shaly interval within the Lower Member Poleta Formation. The bottom of this shaly interval is approximately 315 meters above the horizon of the current *Cirquella* n. sp.. An additional occurrence of *C. nummularia*? is reported in the Death Valley region in California (Fritz 1993).

Cirquella nelsoni is an earlier form from the *Fallotaspis* Biozone in the White Mts, California (Lieberman 2001; see also Nelson and Durham 1966, pl. 2, fig. 4). We believe this species should be restricted to the holotype pending additional data, as the paratype specimen (from a different White Mts locality) is possibly not conspecific. While some authors have assigned it to *Cirquella* (Geyer 1996, p. 187; Lieberman 2001), others have doubted this assignment (Fritz 1993; Hollingsworth 2008b, 2011). We concur with the latter authors that the assignment to *Cirquella* is questionable at present, therefore it is referred to here as *Cirquella? nelsoni* Lieberman. The horizon of this form, although not well constrained in the literature, is estimated at some 60 meters below the newly discovered *Cirquella* horizon (with another possible occurrence reported at an upper horizon close to, but probably just below, the base of the putative *M. parallela* Biozone. (Hollingsworth 2011, fig. 5)).

Thus the range of the genus in the Great Basin is at least ~345 meters; if *C.*? *nelsoni* is verified as belonging to the genus the known range would stand at roughly 410 meters. It is therefore a very long-ranging Montezuman genus.

The new *Cirquella* sp. is preserved as large flattened shale specimens, and shows a relatively wide, forward-tapered glabella with very effaced glabellar and border furrows and a reduced axial furrow. The eye lobes are relatively short and narrow and well separated from the glabella, and the ocular lobes are inclined rather steeply from a sagittal line at the glabellar attachment. The extraocular area is rather wide.

The thorax consists of at least 16 segments, with a holmiid-type morphology (i.e. IPRs that are narrower (tr.) than the axis, short, mildly thorn-like pleural spines and slightly amplipleural T3). The axial rings show small nodes to spinelets that increase in prominence from T1 to T13, and may be absent on T14-16. The pattern of apparent reduction in development of the last few thoracic segments shows some similarity to holmiids (e.g. *Montezumaspis parallela*) and to some fallotaspidines. The posterior few segments of this species are as yet poorly known. Some specimens may show a tendency to "enrollment" similar to that seen in holmiids such as *Esmeraldina rowei* (Walcott).

Comparisons with the described *Cirquella* species are hampered by the fact that all available material of the new form is larger than the known material for the other species (with the exception of one fragmentary *C. espinata*). In spite of this size difference, however, we believe that species-level differences with all 3 forms are apparent.

Figure 1. *Cirquella* n. sp. from the lower Cambrian (Stage 4, Series 2) Montenegro Member of the Campito Formation, Montezuma Range, Nevada. Cranidial length is 19 mm.

The most similar species to the new form is *Cirquella nummularia*, which shares the rounded cephalic outline without sharp genal or adgenal angles. However, it shows a number of character differences from the new form including less effaced cephalic furrows (particularly L0 and the AB furrow), a markedly narrower (tr.) extraocular area, a markedly narrower (sag.) preglabellar field and a narrower (tr.) glabella.

C.? nelsoni shows a number of distinctive differences including narrower cephalon, sharply incised axial (and border?) furrow, more elevated OLs and glabella, markedly less forward taper in the glabella, narrower glabella, and small sharp genal spines. Finally, *C. espinata* shows several marked differences including an acute genal angle.

Similarity is also noted between *Cirquella* n. sp. and *Fritzaspis*, the index genus for the earliest Laurentian trilobite biozone and one of the earliest worldwide trilobites (Hollingsworth 2007). In fact, *Cirquella* n. sp. may possibly represent a transitional form between the earlier *Fritzaspis* and the later species of *Cirquella*. However, we believe *Cirquella* n. sp. and *Fritzaspis* show clear generic-level differences. The top of the *Fritzaspis* zone is located an estimated 157 meters below the new occurrence.

Acknowledgements: Thanks are due to Maria Damiani who co-discovered the occurrence of this new trilobite.

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MINIATURE TRILOBITES

Pete Scholten

In 2018, I accompanied Dr. Fred Sundberg to Split Mountain East in Esmeralda County, Nevada, where we have been several times in the past to collect trilobites for Dr. Sundberg's research. As an avocational paleontologist I am not an expert in the field but I really enjoy collecting and being in the field and hope my contribution, however small, is helpful.

The main area of collection is a trench (Fig. 1), Fred Sundberg is sitting at the top of the *Amecephalus arrojoensis* Biozone and just below the *Oryctocephalus indicus* Biozone. We last visited this area in June of 2018. At the suggestion of Dr. Sundberg we gathered several kilos of shale from the trench to examine at home with microscopes at our leisure instead of looking at the shale through hand lenses while sitting in the sun in the trench.

After looking at thousands of small pieces of shale, some smaller than 1centimeter, many trilobites of a very small nature were found. Surprisingly quite a few of these were complete. There were several different species present. These are pictured here (Figs. 2-6). The smallest one that I collected was 1 millimeter. This is also the smallest complete trilobite I have ever found: a ptychoparoid third stage meraspid (Fig. 2).

Like many an amateur trilobite hunter and col-

Figure 1. Trench through the basal Emigrant Formation at Split Mountain, Nevada. Fred Sundberg is sitting at the boundary of the *Amecephalus arrojoensis* and *Oryctocephalus indicus* biozones.

lector, I started out with the larger Moroccan Devonian trilobites available at the Tucson Gem and Mineral Show and elsewhere. During the past seventeen years there have been many a trilobite collected by myself, under Fred's guidance. Some have been of a good size, including cephalons over 10 centimeters in width, but unfortunately not the whole trilobite. There have been some of those occasional complete and gorgeous bugs that everyone covets.

These miniature specimens amaze me. They are from the middle Cambrian which means they survived about a half a billion years and are still intact, some completely whole, and identifiable down to the species. This is an amazing feat of nature. Whether these tiniest members of the group were the ants of that time, burrowing through the soil of the oceans, or the midges, swimming through the pelagic zones of those Cambrian ecosystems remains somewhat of a mystery. Nonetheless they have become a great addition to my collection.

I am thankful to all of you but very especially Fred Sundberg for all of the friendships and adventures over the years past and those in the future. Also, thanks to those of you who have used some of the specimens I have collected in your scientific treatises. It is nice to know that I have contributed a little to the science of paleontology.

Acknowledgements
Thanks to Fred Sundberg for identifying these trilobites and all of the rest I have collected. Thanks also to Laura Scholten for editing my work and letting me go collect. All photos taken

Figure 2. Ptychoparoid meraspid (1mm in length)

Figure 3. *Onchocephalites claytonensis* (6mm in length)

Figure 4. *Microryctocara nevadensis* (5mm in length)

Figure 5. *Oryctocephalus americanus* (2.5mm in length)

Figure 6. *Oryctocephalus indicus* (5mm in length)

by Pete Scholten.

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Cambrian Stratigraphy and Paleontology Of Northern Arizona and Southern Nevada J. Stewart Hollingsworth, Frederick A. Sundberg & John R. Foster

TRILOLAB

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The Ardenno-Rhenish Massif, which extends from southern Belgium to western Germany, is a classic region for Devonian trilobite studies. While researchers in Germany have produced a steady flow of papers throughout the 19th, 20th and early 21st centuries, things remained rather silent on the Belgian end. In 2005, Ben Magrean and I launched what we termed "a revision of Devonian trilobites from Belgium" (Magrean & van Viersen, 2005). Truth is, there really was not much to *revise*. Apart from a few useful descriptions and illustrations the old literature contained monotonous lists of trilobite names that were already obsolete at the time they were published. Ben and I formed various collaborations with other trilobitophiles. Field excursions at Lochkovian to Famennian outcrops in Belgium have revealed that the trilobite associations are often remarkably rich, both in numbers of individuals and species. And contrary to some previous beliefs preservation is often rather good. We authored a fair amount of papers to document the trilobite specimens and this work is still far from done today. Selected recently published research articles are listed below.

To give the various initiatives and interactions a more organised character, Frederik Lerouge, Ivo Kesselaer and I founded a research group called Trilolab. Trilolab is a non-profit collective of people aiming to collaborate and share knowledge by means of education and (research) articles. Besides the ongoing studies in Belgium, Trilolab extends its scope to fieldwork and Devonian trilobites in Morocco as well as professionalising the preparation of trilobite specimens. We believe that high quality preparation is essential to trilobite studies and we see huge potential among trilobite enthusiasts that just need the right tools and guidance.

Ben and I continue to work with Peter Taghon on early Middle Devonian trilobites from a potentially Choteč interval in southern Belgium subsequent to the work of van Viersen et al. (2019).

Our group is investigating possibilities for establishing an Early Devonian trilobite biostratigraphic framework in the Neufchâteau-Eifel Synclinorium (Belgium, Luxemburg, Germany).

Several systematic works on Devonian trilobites from Morocco are currently in preparation. Phacopid diversity in the closing Rheic Ocean during the Devonian remains a long ranging project.

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Figure 1. *Goldius endelsi* from the Jemelle Formation (Eifelian) in Belgium. Courtesy Didier Lelubre.

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TRILOBITE HALL OF FAME

Memories of Sir James Stubblefield (1901-1999)

Richard Fortey

James Stubblefield was a leading British paleontologist of the 20th Century. He was christened Cyril James, but I never heard anyone address him by his first name. In our community he was generally called "Stubbie", and even his wife called him by this name, at least in company. He will be remembered in perpetuity (as long as there are trilobite specialists) for two papers. Stubblefield (1926) described the ontogeny of *Shumardia pusilla* (*Conophrys salopiensis* these days) from the Tremadocian rocks of western England. It was a superb piece of work that proved that segments were released into the thorax from the front of the pygidium during the meraspis stage, but that their number stayed constant during the later holaspis stage even as overall size increased. When I revised this work with Bob Owens in 1991 we could only add details of the free cheeks, and the benefits of electron microscopy – "Stubbie's" account was accurate. Most of those workers interested in classification will have referred to his 1936 paper on the importance of facial sutures. More locally, he documented the succession of trilobite faunas through the Tremadoc strata of England in a classic paper with O. M. B. Bulman published in 1927. I treasure a reprint given to me more than forty years later inscribed “belated greetings from the author”.

Stubbie had a distinguished career in scientific administration. He was Director of the UK Geological Survey (1960-66) and president of the Geological Society of London (1958-60). This is why he was given that curiously British honour of being called “Sir” – no doubt it was accompanied by tea with the Queen, which most of us would like if given the chance. I followed him as “Geol. Soc.” president 46 years later. By the time I joined the Natural History Museum in London in 1970 he had retired. Typically, he had accepted the modest role as recorder for the *Zoological Record* (Trilobita), a bibliographic resource of great importance to fledgling researchers and old hands alike. I like to think that his periods (more than one) in this role mark the acme of its accuracy and comprehensiveness. He would often contact me during this time. He was a small, lively figure, with thinning hair, dressed in a suit, who could be found leafing through the recent acquisitions in the museum Library. He had an old fashioned way of gently laughing at the mistakes of others. A little pernickety, he was always trying to run down the more obscure publications by Russian authors – at that time a bibliographic nightmare. The job of recorder involved listing all the new species, and I recall with gratitude his finding a series published by the Arctic Institute in Leningrad (today’s St Petersburg) that included taxa with which I was concerned at the time. On his 80th birthday he asked me out to lunch in an old ‘relic’ restaurant in South Kensington –Daquise – that had remained almost unaltered since Polish emigres had settled there after WW2. The menu was the same as well, with borsht and mushroom soup and pierogi. He told me stories about the Richters (in happier prewar times), Christian Poulsen, Pierre Hupé, and of Percy E. Raymond, Benny Howell and Teichi Kobayashi, which made me aware of the deeper history of our specialization. We do follow on from our predecessors even if we don’t agree with the way they did things.

“Stubbie” continued to serve paleontology behind the scenes into extreme old age. He was on the Council of the Palaeontographical Society for many years, and had long supported the Survey’s slowly dwindling band of paleontologists to be involved with Britain’s own monographic series, which dated back to Darwin’s time. He became very deaf, and Council meetings were often brought to a halt by his cry of “What’s he say?” He was guaranteed to shout out “Is he a Member?” when some new title was offered to the Society. We missed him when he finally stepped down. At his death I believe he was the oldest member of the Palaeontological Association.

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Stubblefield C.J. and O M B Busman 1927 The Shineton Shales of the Wrekin district. Quarterly Journal of the Geological Society of London, 83, 96-146

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GUNTHER HALL OF FAME

A Tribute to Dan Cooper

Don Bissett; Dry Dredgers Fossil Club (Cincinnati, Ohio, USA), Norton Shores, Michigan, USA; email: donbissett@gmail.com.

I’ve had the opportunity and privilege to collect trilobites with Dan Cooper (Fig. 1) for four decades. We first met through the Dry Dredgers, a

Figure 1 MAPS President Marvin Houg (left) presenting the Don Good Award to Dan Cooper (right) on March 31, 2017 in Iowa City, Iowa during the MAPS annual show.

fossil club affiliated with the University of Cincinnati. At the time, Dan was the club's field trip chairman. It wasn't long before we were collecting together across many localities in the US, from New York to Tennessee to Oklahoma to Wisconsin, and numerous sites in between.

While Dan is an avid collector, he is also driven by the need to share his discoveries with professional paleontologists. He routinely invites professionals to join him on his far-flung explorations to find new sites, and rediscover lost ones. As an example, he rediscovered the New York Beecher pyritized *Triarthrus* bed, which was thought to be lost upon the death of Charles Emerson Beecher (Yale University) in 1904. But Dan and Tom Whiteley (another avocational collector) found it and shared the location with professionals (1). Another of these collaborations, on a *Flexicalymene granulosa* locality in the Cincinnati area, led to a publication on which Dan is co-author (2).

An additional locality that Dan reopened is the renowned Walcott-Rust Quarry in New York. The site was originally collected in the late 1800s by Charles Doolittle Walcott and William Palmer Rust (3). This private property was reopened by Tom Whiteley in the 1990s for study (4). Then it lay dormant for many years, until Dan leased the land and reopened it, making it available once again to collecting and to professionals.

Dan also routinely donates material to clubs and institutions. For example, he bought several acres of property and developed the now famous Ordovician trilobite locality in Mt. Orab, Ohio. He led many field trips there. From that site, he collected, prepared, and donated to the Smithsonian a large slab of shale containing 3 prone *Isotelus* (the official state fossil of Ohio). For many years, that slab was (and may still be) on display at the National Museum of Natural History in Washington DC. The site was also made available to two graduate students for their thesis projects on the trilobites (*Isotelus* and *Flexicalymene retrorsa*) found there (5,6).

In my previous article in The Trilobite Papers

Figure 2. Prone *Flexicalymene meeki* (Foerste 1910), Ordovician, Mayville Formation, Corryville Member, Richwood, Kentucky. Pictured specimen is 2.5 inches long. The trilobite was prepared by Ben Cooper.

(7), I discussed the role of amateurs in keeping the Penn Dixie (New York) trilobite locality open to collectors. Dan was instrumental in that, working with the local Hamburg Natural History Society to develop a plan that allowed trilobite collecting, while at the same time replenishing the common fossils on the surface to be found by busloads of school children for Penn Dixie's educational programs. Families, amateurs, geology classes, and professionals now routinely visit Penn Dixie.

Dan continues to reopen old sites and scout new ones. Figure 2 shows a trilobite from one new exposure he discovered just a few years ago in Northern Kentucky. This 2.5-inch *Flexicalymene* is a giant for the genus in the Cincinnati Arch. Consistent with Dan's generosity, local professionals (from University of Cincinnati and Cincinnati Museum Center) were invited to the locality for study. Sadly, the exposure is now gone, buried under a warehouse.

For his many contributions to the hobby, to paleontology, and to the organization, Dan was presented with the Don Good Award at the 2017 MAPS (Mid-America Paleontological Society) annual show in Iowa City, Iowa (8). Don Good was a co-founder of MAPS more than 40 years ago.

Dan has passed along his enthusiasm for trilobites to his sons and grandsons. Since his father also did some collecting, that makes four generations of trilobite collectors in the Cooper clan. I wish them "Good hunting."

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Samuel M. Gon III

Danita Brandt, Michigan State University, E. Lansing, MI

The nomination of Samuel M. ʻOhukaniʻōhiʻa Gon III (Fig. 1) for the Gunther Hall of Fame is perhaps unusual in several respects. I, the nominator, have never met Sam Gon in person, although we have corresponded, once, as I will describe. Sam is nominated not for the more traditional reasons of discovering and sharing with professional paleontologists important fossil finds, but for creating and maintaining a website. This is not just any website; this is the website that can claim the top response to the Googled question, "What is the most used website for information about trilobites?" Sam's website, www.trilobites.info has garnered dozens of website kudos since its inception in Janu-

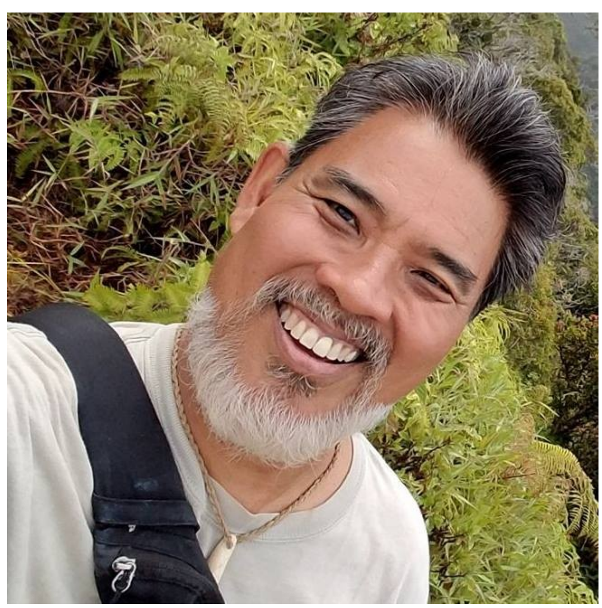

Figure 1. Samuel M. ʻOhukaniʻōhiʻa Gon III

ary, 1999, and continues to be the most-consulted (second only to Wikipedia in some search terms) online source for all things trilobite. As author of a widely accessed online resource, Sam's reach and influence is global. Content from his site shows up in countless (I have tried!) other websites from around the world (detailed, below). Fortunately for us paleontologists, his content is scientifically sound. Sam is a zoologist by training, and his scientific rigor is evident on each of the 100+ pages that comprise the site. In this day of "alternative facts" and active disinformation campaigns it is good to know that, when it comes to all things trilobitoidea, Sam's science-based website remains the primary source of information for internet users.

Sam is also a gifted illustrator. He realized he would have to supply his own trilobite line drawings for the website so he mastered Macromedia Freehand. Sam's drawings are widely used ("borrowed" in some cases, used with permission in others) by other websites including *The New York Times*, and have graced the pages of *American Scientist* to accompany an article by eminent trilobitologist Richard Fortey. Sam's gift as a trilobite illustrator is matched by his generosity in sharing the fruits of his labor. I am one of the many professional paleontologists who have benefitted from his artistic largess. Sam was quick to grant me, whom he had not met, permission to use one of his clever animations for a presentation, a calymenid in the act of enrolling (www.trilobites.info/enrollment.htm). I've long forgotten the subject of my talk, but I remember the animation!

Content from www.trilobites.info is reproduced in websites and publications around the world. To date I have documented acknowledgment of his work from the UK, Belgium, Germany, Czech Republic, Australia, Sweden, and Mexico. Both professional sites (e.g., The UCMP Berkeley paleontology pages) and enthusiast pages (e.g., the Dry Dredgers and their compatriots around the globe) make use of Sam's materials. His content turns up in college-level paleontology lab manuals, a Science Olympiad site for middle- and high-school, and in the pages of *Acta Paleologica Polonica*.

For his contribution as a provider of quality online content to trilobite enthusiasts of all ages and abilities around the world and for his generosity in sharing his talents for the advancement of science in general, paleontology in particular, and trilobite studies most specifically, Sam Gon is a worthy recipient of the Gunther Hall of Fame.

ILLUSTRATING TRILOBITES

Kane X. Faucher

When I was in my late teens, there were a lot of different pathways that, for one reason or another, I ended up abandoning. From interests in being a poet, musician, and animator, I found myself instead drifting into other fields, which led me through literature and philosophy until I eventually found myself where I am now: a professor of political economy and municipal affairs. About six years ago, I began revisiting some of my childhood passions, and one of those was fossil collecting. I have very fond memories as a child, growing up among the black Upper Ordovician shales of Ottawa, Canada, of finding heavily pyritized nautiloids and numerous *Pseudogygites latimarginatus* moults. My return to fossil collecting started specializing in trilobites, and since then I've had the opportunity to go out and collect at numerous sites near and far to move tons of rock with good field comrades, amass a nice collection, develop preparation skills with excellent equipment, and to read voraciously any and all scholarly literature on trilobites. But the one last missing component was to revisit my old passion for illustration.

At first, the skills were a bit rusty after two decades of drawing inactivity, and so the drawings were more imprecise sketches. With practice, I

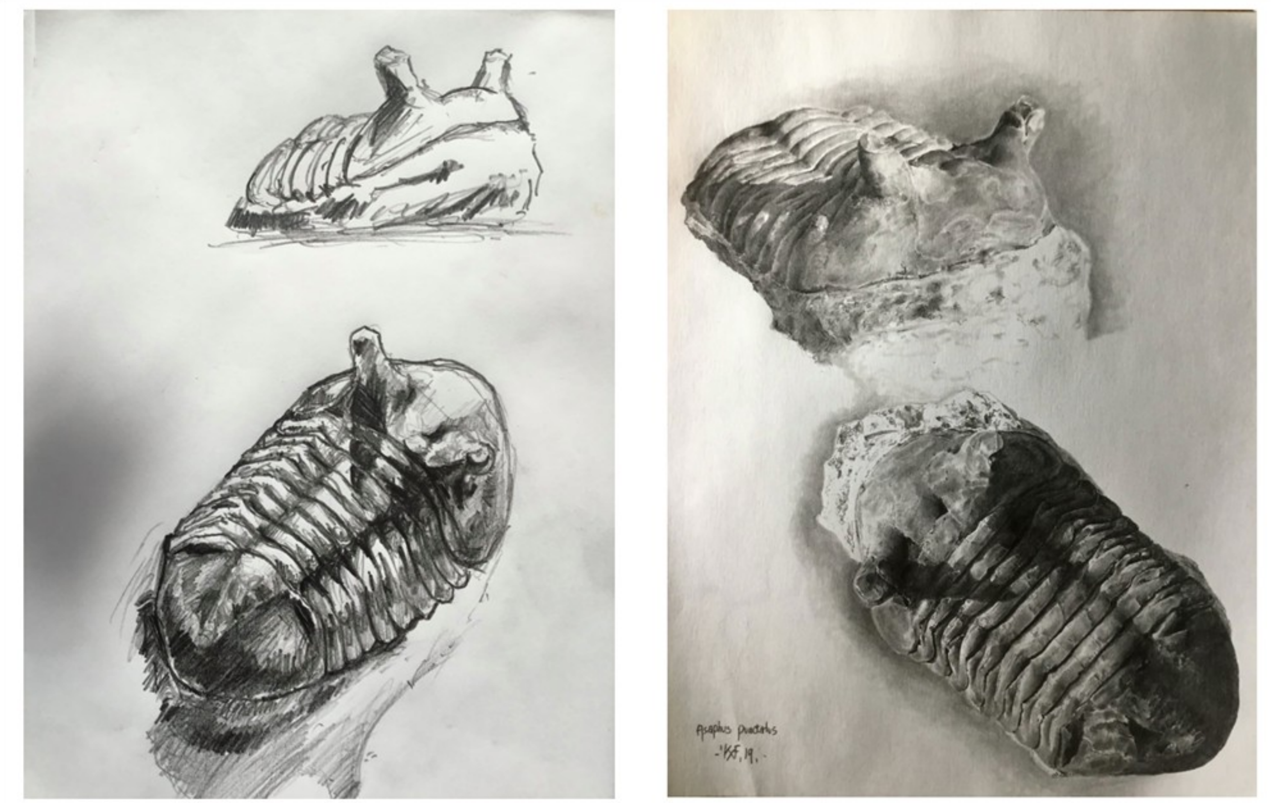

Figure 1. An initial sketch of an *Asaphus punctatus* in July 2018, and the same subject a year later

was able to fine tune my illustrations to obsess over every small crack in the cuticle, every mottled bit, and the subtle nuances of the microsculpture. Now, it may take more hours to illustrate trilobites in my collection as it does for me to prepare them in my small lab. And, just like it was with preparation, the earlier attempts were crude and full of mistakes. Of course, unlike preparation, mistakes are more easily managed with an eraser!

My drawing tools are far less specialized than my collecting or preparation tools. A humble array of pencils, blending stumps, the specimen, lighting, music, magnifier, and some water. Before the advent of photography (and for some time after), illustration was the only visual means to depict trilobites in academic works. It is not hard to draw inspiration from the illustrators of natural history texts of the past and their painstaking attention to detail as per

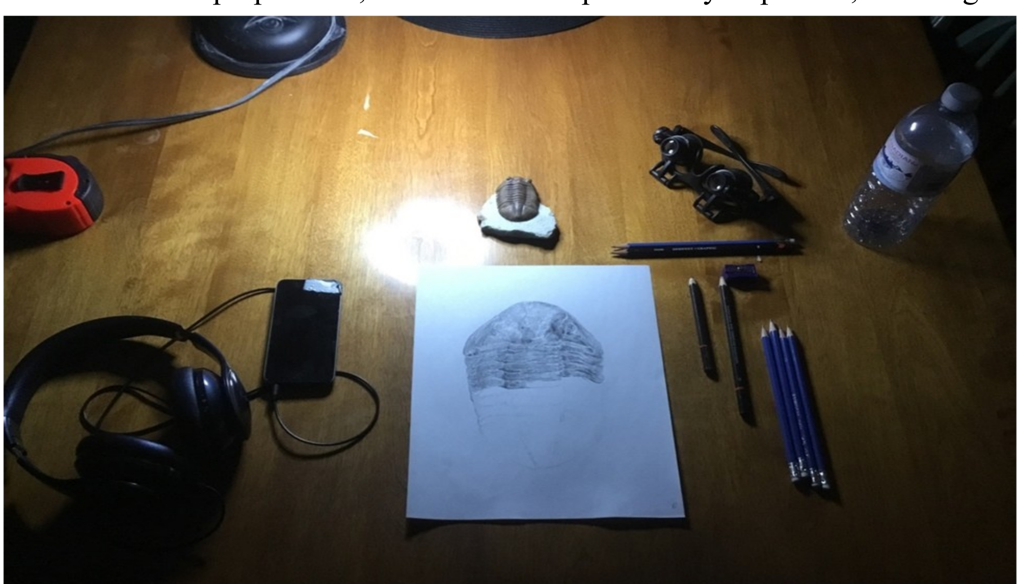

Figure2. The humble dining room studio

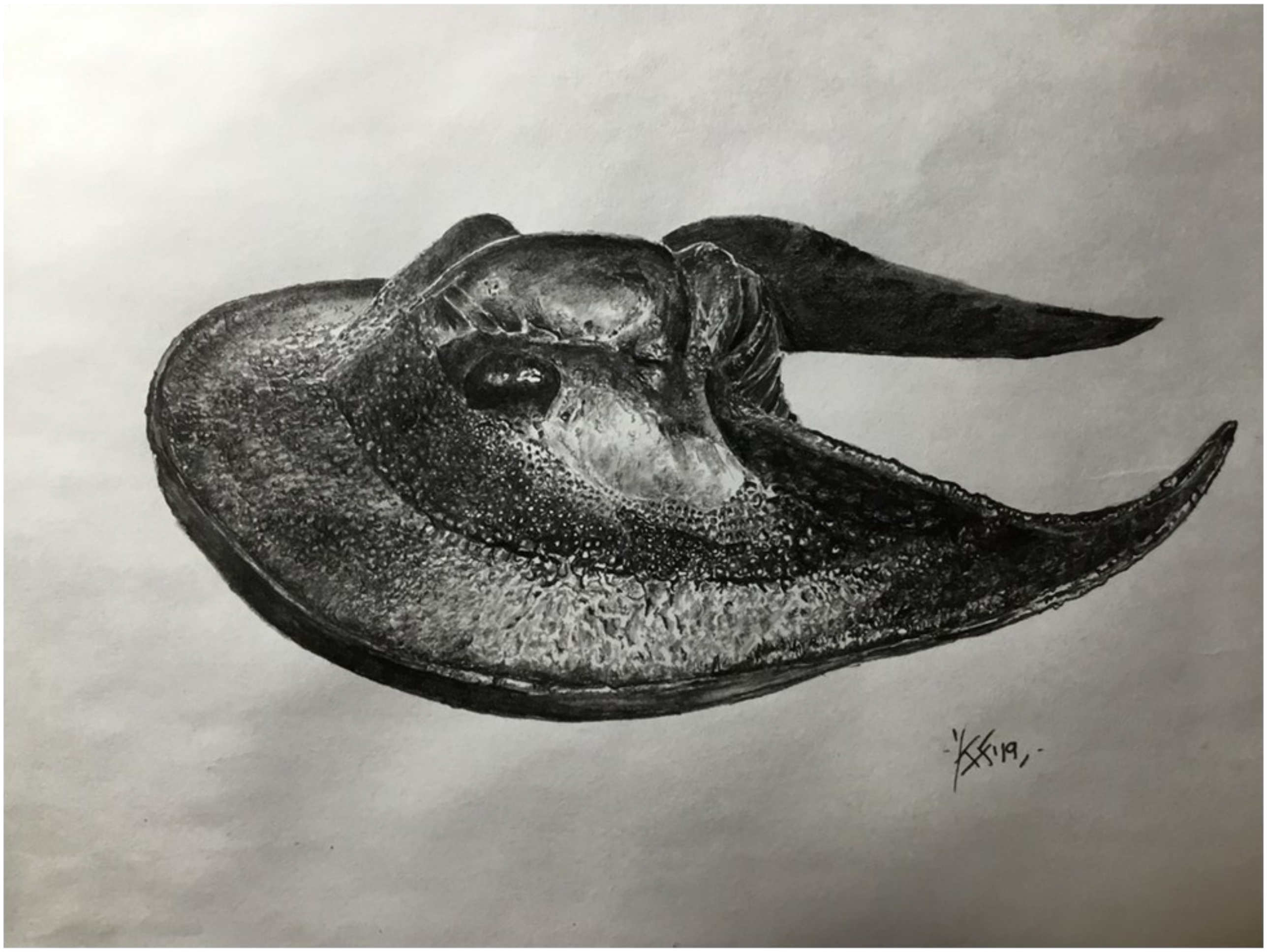

Figure 3. Harpes perradiatus

the demands of scientific accuracy.

Although I do draw from my collection, I also render from images found online, or supplied to me from other collectors. I have experimented

with colouring pencils and other media, but I find the humble grey scale effect of the graphite pencil my most favoured approach, perhaps as a small homage to the tireless trilobite illustrators of a bygone era.

For me, to illustrate trilobites in the collection is a way of paying a small tribute to their fascinating, diverse, and sometimes slightly nuanced morphological characteristics. When drawing specific examples, one certainly gains an appreciation for their minute differences and unique character; no two *Greenops widderensis* are identical, and one cannot assume that the length of a genal spine, a diminutive tubercle, or the gentle curve of a pleural facet will fully resemble the photo plates in a journal. Just as it is with preparation, so too are appreciating the unique differences in illustrating.

In this age of high megapixel digital photography and editing software, it may seem anachronistic to represent trilobites through the imprecision and vicissitudes of the human hand. However, I hold out some small hope that there is still a space for the humble but dedicated illustrator. And, besides, with the long and brutal interruptions of our cold Canadian winters that keep some of us from being able to get out into the field, when one has already prepared all the previous season's finds, and when caught up on the latest trilobite research, drawing trilobites is a way of indulging the passion and appreciation of these fine creatures.

Figure 4. Gabriceraurus dentatus

Bio: Kane Faucher is an Assistant Professor at Western University and Huron University College (London, Canada) where he teaches political economy, local government, and management studies. Whenever time and opportunity allow during the snow-free months, he can be found splitting rocks at various locations.

Figure 5. I*sotelus sp.*

Figure 6. *Flexicalymene retrorsa* pair

Figure. 7. Roger's "Kermit" (*Isotelus gigas*)

EARLY EXPEDITIONS INTO MOROCCO'S PAST: THE FIRST DISCOVERIES OF CAMBRIAN TRILOBITES IN AFRICA

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Bohemia, Wales, Sweden and several other regions of Europa are generally known as the home of Cambrian trilobites since the mid-19th century, predating early discoveries of Cambrian trilobites in North America, Australia, Siberia and China. The earliest encounters of Cambrian trilobites from Africa were made in Morocco, but even trilobite specialists are often surprised by when and where these discoveries took place. A bit of this history of the discoveries was reported by Despujols (1933), David & Miguet (1969), Henry Hollard (in Destombes et al. 1985), Medioni (2008, 2011, 2015) and Debrenne (2014), but these data are reported in some more detail or alternative aspects below.

The first discovery of Cambrian rocks with trilobite fragments were made by Louis Gentil in 1916. Louis Gentil (1868–1925) was an Algerian-born geographer, geologist and mineralogists, who became a lecturer at the Sorbonne University in Paris. From 1902, he was interested in the geology of Morocco and undertook a number of travels for field studies, culminating in a report in 1906, accompanied by a map at 1 / 250.000 and a geological sketch of Morocco in 1912. In 1913 he proposed to establish a scientific *Institut Scientifique Cherifien*, the responsibility of which should include to create a geological map of Morocco and to specify the water resources. This institute was founded in 1920. Gentil continued the explorations of the Moroccan Atlas until his death.

Gentil unearthed middle Cambrian trilobites on the airfield at Casablanca in 1916. It should be noted that this airstrip can be matched with the airport portrayed in the famous movie Casablanca, but should not be confused with the present-day airport Casablanca, which is located way east of the town. Ironically, another airfield was named after him. This Louis Gentil Field is now abandoned and lies located approximately 6 km north-northeast of Youssoufia, about 170 km southwest of Casablanca.

Unfortunately, Gentil did not recognize the trilobites from Casablanca as Cambrian in age so that this important discovery remained unknown for quite some time until the trilobites were identified correctly as middle Cambrian in age later. In Gentil's map the Cambrian outcrops are shown as Cretaceous in age. Subsequent comparison with Silurian fossiliferous strata from regions with similar facies prompted to consider the Cambrian rock as Silurian.

Thus, Cambrian trilobites were in fact discovered first by Georges Lecointre (Fig. 1) as shortly discussed in last year's *Trilobite Papers 20*. This note from 1918 was the first report on the presence of Cambrian (and Ordovician) in northwestern Africa, which is also the first recognition of trilobite-bearing Cambrian in entire Africa.

Georges Lecointre (1888–1972) was introduced to paleontology in his early youth by his mother, Countess Henriette Valentine Huberte "Pierre" Lecointre, who in her Chateau de Grillemont had a considerable fossil collection. After obtaining a degree in chemical engineering in Nancy in 1906, he switched to geology. In 1913, Émile Haug proposed to him to study the Neogene and the Quaternary of the Atlantic coast of Morocco. A grant allowed him to travel to Morocco in 1914, where he began to work on a thesis in the North of Oued Sebou but then was mobilized on the spot for the French army. Gravely

Fig. 1. Georges Louis Lecointre (1888–1972). Photo: Histoire de l'Agriculture en Touraine.

ill, and hospitalized at the hospital of Anfa, near Casablanca, he took advantage of his convalescence to discover Cambrian faunas at Paradoxides in slates and quartzites on the coast near Casablanca. In 1918, Lecointre noted that he had studied a section near Ilo't de Sidi Abderrahmane, a tiny village in the outskirts of Casablanca in Morocco, in July 1917. Another, now more frequently cited locality with Cambrian trilobites discovered by Lecointre is referred to as Sidi Abdallah bel Haj, which is located at the sea-shore north of Aïn Sebaa quarter in the northeastern part of Casablanca (Figs. 2, 3).

Lecointre had discovered numerous trilobite remains, including some thoracic fragments, which he regarded as poorly preserved, but identified "a cephalothorax and abdomen without pygidium [sic!] reminiscent to forms of the genera *Ptychoparia* Corda or *Hicksia* Delgado, cephalothoraces seemingly similar to the genus *Anomocare* Angelin, and finally an abdomen with pygidium and cephalothorax of a *Paradoxides* similar to *P. Barrandei* Barrois and *P. mediterraneus* Pompeckj …" (my translation from p. 611). Lecointre correctly stated that the presence of *Paradoxides* (Fig. 3) indicates a middle Cambrian age ("Acadien") and discussed similar rocks from other localities in the Casablanca region, but without any fossil findings being mentioned. Findings of brachiopods brought him to suggest a possible Silurian age for the strata in which they were found, but the identification remained uncertain.

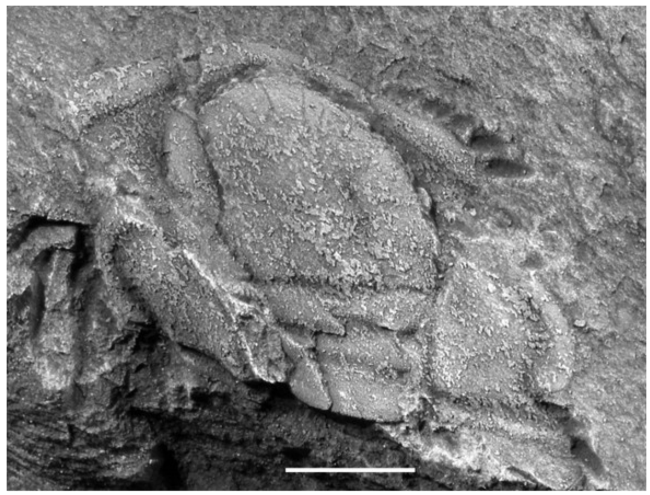

Fig. 2. *Eccaparadoxides*? sp., cranidium. Original specimen of Lecointre (1923) from the Miaolingian near Casablanca, Morocco. Previously unregistered specimen, now collection of the Institut de Géologie, Université de Rennes, France, IGR 23091

These trilobites were later referred to as "*Paradoxides mediterraneus*, *Conocoryphe heberti*, cf. *Ptychoparia Ribeiro*, and cf. *Sao hirsuta* (= *Ptychoparia, Barthouxi*)" (sic, Moret 1931). The determinations originate in part from a short paleontological study of the trilobites by Mansuy (1922), who introduced the new species *Ptychoparia barthouxi* (Fig. 4), a typical and close relative of the widespread *Badulesia tenera*, which indicates a Drumian age for the strata in which it occurs. However, a precise and reliable analysis of the fauna is still lacking. Nevertheless, the Sidi Abdallah bel Haj locality became quite renowned as a fossil site, particularly by recollection of trilobites by Balloy (1949). Some of Balloy's specimens are shown in Figs. 3.

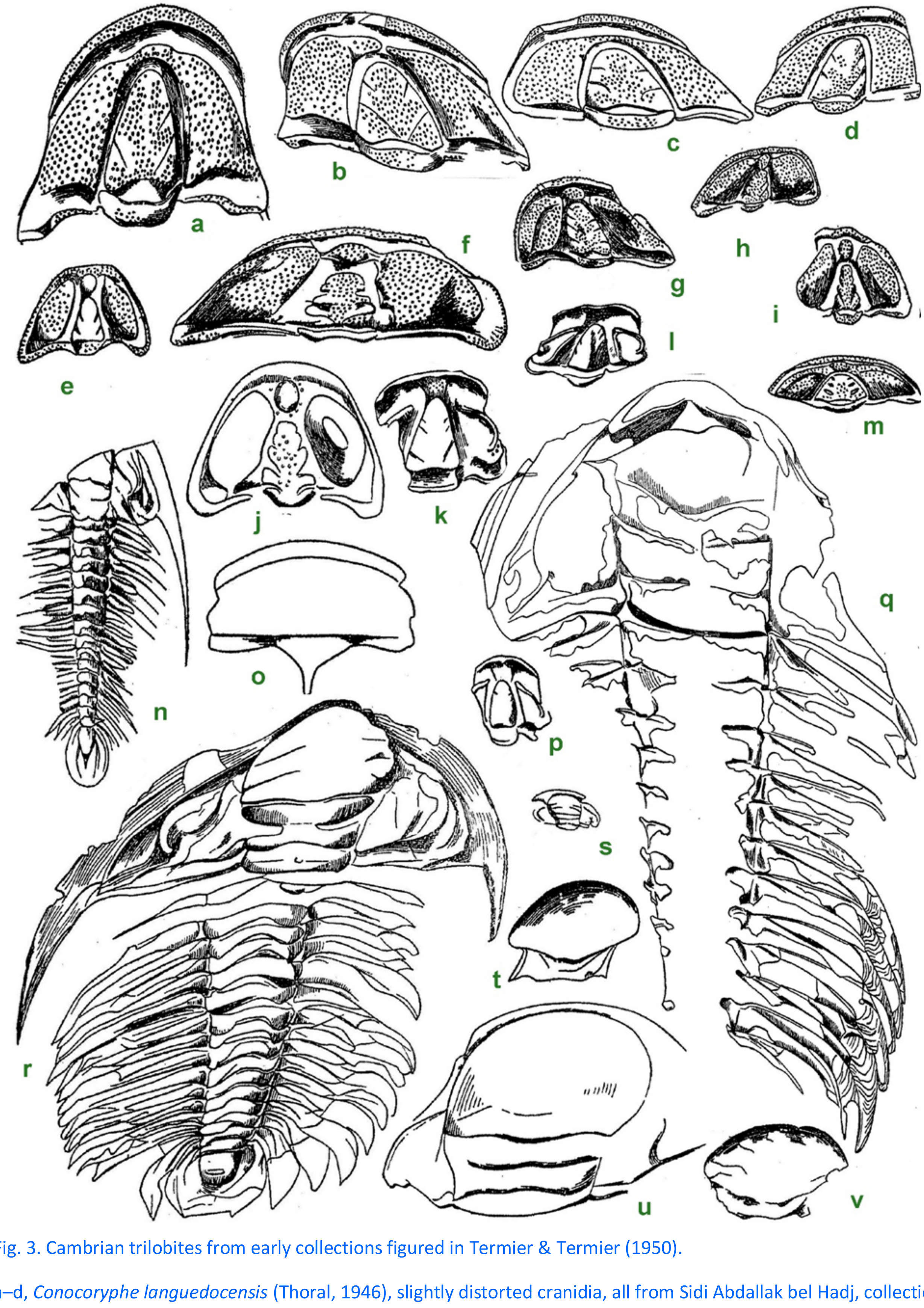

Fig. 3. Cambrian trilobites from early collections figured in Termier & Termier (1950).

a–d, *Conocoryphe languedocensis* (Thoral, 1946), slightly distorted cranidia, all from Sidi Abdallak bel Hadj, collection of Balloy. Determined in Termier & Termier (1950) as *Couloumania brevifrons* Thoral. a = Termier & Termier 1950, pl. CLXXXV, fig. 12; b = , Termier & Termier 1950, pl. CLXXXV, fig. 16; c = Termier & Termier 1950, pl. CLXXXV, fig. 15; d = Termier & Termier 1950, pl. CLXXXV, fig. 17. (x 2).

Caption continued on next page.

Fig. 3. Continued

e, f, h–j, Harttella terranovica (Resser, 1937), slightly distorted cranidia, all from Sidi Abdallah bel Hadj, collection of Balloy. Determined in Termier & Termier (1950) as “Ctenocephalus terranovicus Resser”. e = Termier & Termier 1950, pl. CLXXXV, fig. 10; f = Termier & Termier 1950, pl. CLXXXV, fig. 11; h = Termier & Termier 1950, pl. CLXXXV, fig. 20; i = Termier & Termier 1950, pl. CLXXXV, fig. 24; i = Termier & Termier 1950, pl. CLXXXV, fig. 18.

g, m, Ctenocephalus cf. antiquus Thoral, 1946, slightly distorted cranidia, both from Sidi Abdallah bel Hadj, collection of Balloy. Determined in Termier & Termier (1950) as “Ctenocephalus terranovicus Resser”. g = Termier & Termier 1950, pl. CLXXXV, fig. 19; i = Termier & Termier 1950, pl. CLXXXV, fig. 21.

k, l, p, Badulesia barthouxi (Mansuy, 1922), slightly distorted cranidia, both from Sidi Abdallah bel Hadj, collection of Balloy. Determined in Termier & Termier (1950) as “Ctenocephalus cf. Bergeroni Thoral”. k = Termier & Termier 1950, pl. CLXXXV, fig. 23; l = Termier & Termier 1950, pl. CLXXXV, fig. 14,; p = Termier & Termier 1950, pl. CLXXXV, fig. 22.

n, Eccaparadoxides aff. lamellatus (Hartt in Dawson, 1868), incomplete dorsal exoskeleton; from Sidi Abdallah bel Hadj, collected by Lecointre. Determined in Termier & Termier (1950) as “Paradoxides mediterraneus Pompeckje”. Termier & Termier 1950, pl. CLXXXVIII, fig. 22.

o, Mesetaia xx Gigout, Xx, cranidium, from Sidi Abdallah bel Hadj, collection of Balloy. Determined by Termier & Termier (1950) as “Hartshillia inflata Illings”. Termier & Termier 1950, pl. CLXXXV, fig. 25.

q, u?, Hydrocephalus? sp., incomplete dorsal exoskeleton and partial cranidium; from Casablanca area, collected by Balloy. Determined in Termier & Termier (1950) as “Paradoxides cf. imperialis BARRANDE”. q = Termier & Termier 1950, pl. CLXXXIX, fig. 1; u = Termier & Termier 1950, pl. CLXXXIX, fig. 2.

r, Eccaparadoxides sp. A, incomplete dorsal exoskeleton, from Sidi Abdallah bel Hadj, collected by Balloy. Determined in Termier & Termier (1950) as “Paradoxides cf. lamellatus Dawson. Termier & Termier 1959, pl. CLXXXX, fig. 1.

S, Eccaparadoxides sp., small cranidium, from Sidi Abdallah del Hadj, collected by Lecointre, Determined in Termier & Termier (1950) as "Paradoxides mediterraneus Pompeckje”. Termier & Termier 1950, pl. CLXXXVIII, fig. 25.

t, v, Eccaparadoxides? sp., two incomplete hypostomata, both from Sidi Abdallah bek Hadj, collected by Balloy. Determined in Termier & Termier (1950) as “Hypostomes” and figured in reverse position. t =Termier & Termier 1950, CLXXXV, fig. 26; v = Termier & Termier 1950, CLXXXV, fig. 27

This discovery temporarily reoriented the research of Lecointre, which focused on the Paleozoic lands of the western Meseta and culminated in 1926 with the first regional monograph published on Morocco (Lecointre 1926). Later he devoted his work mainly to the study of Pliocene and Quaternary strata in western Morocco.

The first trilobites in the Jbilet region in the southern part of the Moroccan Méséta were discovered by Jean Barthoux. He collected trilobites from slaty argillaceous shales, which he correctly identified as middle Cambrian in age (Barthoux 1924). Before his results, Mansuy (1922) published a short note on these trilobites in which he determined the well-known Bohemian “*Paradoxides rugulosus* Corda”, “*Paradoxides* (*?*)”, “*Conocephalites sp. ? aff. C. Sulzeri* Schlotheim”, “*Conocephalites* sp. (*?*)”, and “*Ptychoparia Barthouxi n. sp.*”. Mansuy was obviously influenced by the at that time low number of middle Cambrian trilobites, which were dominated by Bohemian species. However, he recognized a new species “*Ptychoparia Barthouxi*“, which he compared with “Ptychoparia striata Emmr.” From Bohemia. In fact, *Badulasia barthouxi* is a trilobite species most similar to *Badulesia tenera* and of high significance for biostratigraphy and intercontinental correlation. The species is fairly common in the Oued Djemat section, and original material from the collections by Barthoux in 1923 is shown in Figure 4.

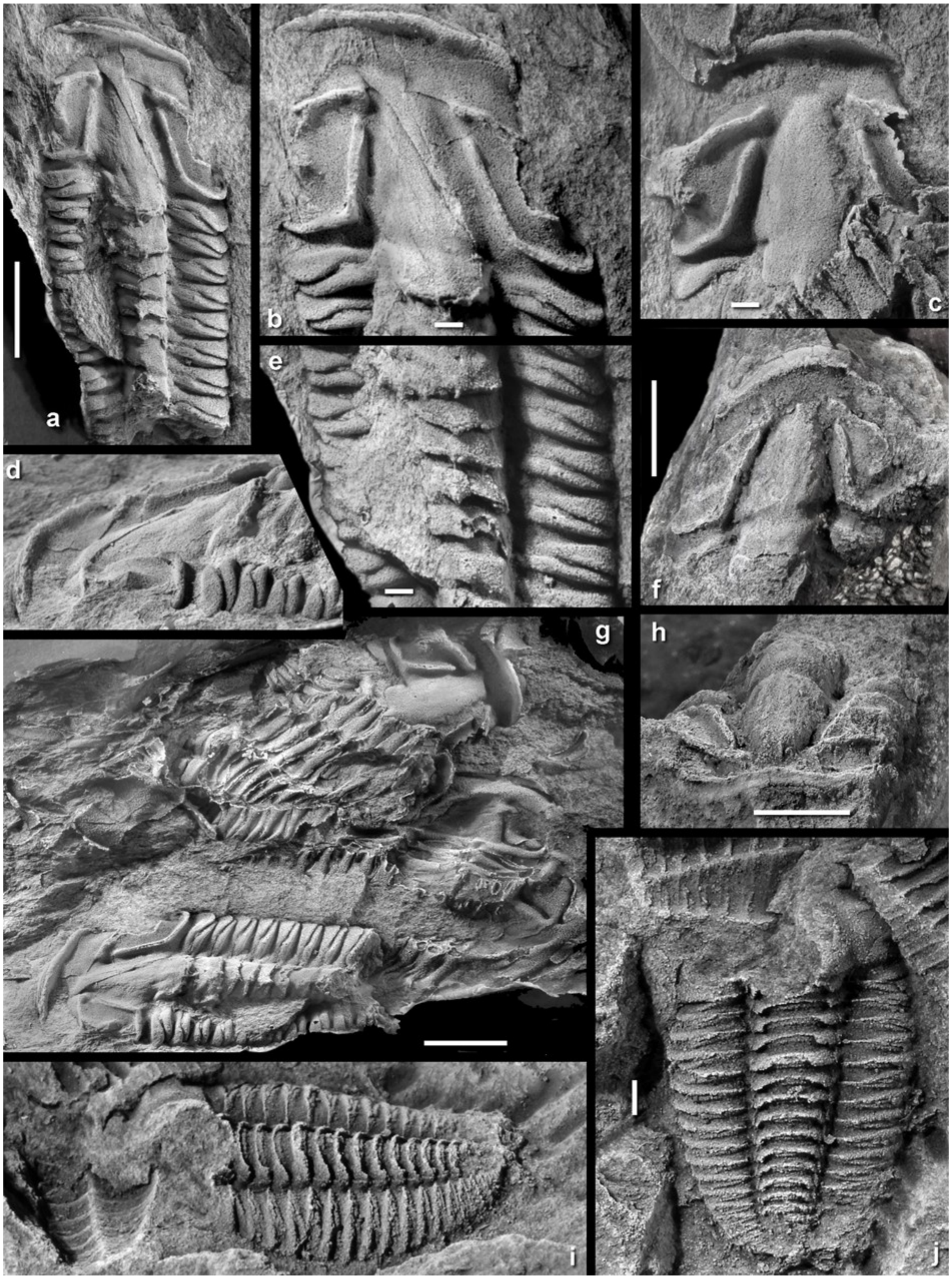

Fig. 4. Trilobites from the Oued Djemat section collected by Jean Barthoux in 1923. Previously unregistered specimens, now collection of the Institut de Géologie, Université de Rennes, France. a–h, *Badulesia barthouxi* (Mansuy, 1922); a–e, g, partial dorsal exoskeletons, latex casts of external moulds on a single slab; IGR 23004a (ki 914); f, h, incomplete cranidium, exterior of cuticle; IGR 23004b (ki 914). I, j, *Conocoryphe* sp., thorax with attached pygidium, internal mould; IGR 23005 (ki 945).

On the international stage, the Palaeozoic of Morocco was reported for the first time by Philibert Russo in the International Geological Congress of Liège in 1925. Russo presented a list of fossils discovered in 1917 in the Casablanca Bay and As a result, Russo suggested a mid Cambrian age for the strata bearing and rejected previous age assignments.

At about the same time, Gentil conducted exploration field-trips. In 1924, he reported the presence of a thick lower Cambrian carbonate succession in the Anti-Atlas. Unfortunately, he only sampled brachiopods and fragmentary trilobites which were inadequate to date these strata precisely.

The first recognition of lower Cambrian in Africa dates back to the discovery of reworked limestones boulders with archaeocyaths and trilobite cross-sections by Jacques Bourcart in 1927. These limestones at the beach of Sidi Moussa (or Mouça) d'Aglou, west of Tiznit at the western tip of the Anti-Atlas, also include plenty of trilobite sclerites, which remained unstudied to date at that time (Bourcart 1927; Bourcart & Le Villain 1928a, 1928b, 1929, 1931). The report is also the first well-recognized record of Cambrian fossils from the Anti-Atlas and thus the early Palaeozoic Souss basin. Jacques Bourcart (1891–1965) was a French geologist and oceanographer, who prepared his Ph.D. thesis at Sorbonne University in Paris 1922 on the geology of Albania and became director of the above mentioned Institut Chérifien in Morocco in 1925 before he went back to the Sorbonne in 1933.

Almost synchronously with Bourcart's study in the western Anti-Atlas, three other geologists made important discoveries on the Cambrian in Morocco. Édouard Roch (1901–1975) discovered Cambrian rocks in in the western Jbilet region in 1927 (Roch 1927). A synthesis of stratigraphical data was published by Roch in 1950. Philibert Russo, senior delegate of Morocco on the International Geological Congress in Brussels in 1922, also discovered Cambrian rocks in the Jbilet region in the Jbel Irhoud are in 1927 (Russo 1927). Russo (1885–1965; Fig. 5) studied medicine and natural sciences and got his Ph.D. at the University of Lyon in biology in 1912. Starting his professional career in Tunisia, he became a military physician in Morocco from 1913 up to 1938 and leader of the hydrogeology department of the Institut Chérifien in 1927. It should be mentioned that Russo was one of the early scientists promoting the continental drift (Russo 1930, 1933).

His works on Jbel Irhoud was a by-product, but the area recently gained a pronounced interest because of the findings of ancient remains of *Homo* and its impact on the pan-African history of *Homo sapiens* (e.g., Hublin 1992; Richter et al. 2017). Russo's discoveries included archaeocyaths in the area, which is the oldest report on early Cambrian rocks in the Méséta basin. How-

Fig. 5. Philibert Russo (1865–1925). Reproduced from David & Miguet (1969).

ever, he also was able to synthesize a stratigraphic section with Barthoux' earlier discovered Paradoxides slates on top, now with the trilobites identified as *Paradoxides spinosus*, *Agraulos ceticephalus*, and *Conocorphe heberti*. This unit is underlain by slates and quartzites with Paradoxides. The basal unit was that archaeocyath-bearing limestones (Russo 1927; Roch 1930).

Louis Neltner discovered Cambrian rocks in the High Atlas ranges in 1928 (Moret & Neltner 1928) and extended his work leading to the recognition of trilobite- and archaeocyath-bearing lower Cambrian rocks, including a first report of the faunas from the now renowned Tiout section (Neltner 1929). Neltner (1903–1985; Fig. 6) was a mining engineer and geologist, who became deputy chief of the Department of Mines and Geological Map of Morocco from 1927 to 1931, together with Pierre Despujols. In 1931, he became professor of geology at the School of Mines in Saint-Etienne, but he continued episodical work in Morocco until the 1950s. Bondon and Neltner discovered a now famous fossil locality near Ouriken n'Ouarmast, (now Orika Wawrmast, close to Ouarzazate), which was

Fig. 6. Louis Neltner (1903–1985). Photo: Ecole des Mines de Saint-Etienne.

termed "Brèche à *Micmacca*" (Bondon & Neltner 1933), which is considered a key level for the lower–middle Cambrian boundary interval (Geyer 1989, 1990). This level allowed correlations with strata in the UK and North America, and it contributed to distinguishing the "Georgien" (="Lower Cambrian") from the "Acadien" (="Middle Cambrian").

Among Neltners's major contributions were studies in the stratigraphy and trilobites from the High Atlas and the Anti-Atlas (Neltner 1935, 1938, Neltner & Poctey 1947, 1950) which predate the major monograph on the Cambrian biostratigraphy and taxonomy of trilobites by Hupé (1953).

Cambrian rocks of quite different stratigraphical levels, often fossiliferous, were discovered at a numerous different localities in the High Atlas and Anti-Atlas ranges of southern Morocco between 1932 and 1934 (e.g., Fallot, 1933; Bondon & Neltner 1933; Bondon et al. 1934; Clariond 1934, 1935; Clariond et al. 1932, 1934), Clariond & Termier 1933).

The Cambrian in the eastern part of the Anti-Atlas and its trilobite content was first studied in some detail be Louis Clariond (1900–1961). Clariond was a civil mining engineer, who entered the *Bureau de Recherches et de Participations Minières* (BRPM) in 1930. In addition to his regular duties for the organization he undertook important basic studies on the Moroccan geology and particularly the coal basins. In 1935, he studied the Sarhro, Maïder and Tafilalet regions of the central and eastern Anti-Atlas, where he recognized the Precambrian basement series to be unconformably capped by a seemingly "Cambrian" volcanosedimentary complex. This "Cambrian" is now known as the Ediacaran Ouarzazate Supergroup, which was assigned to the "Georgien" as well in Neltner (1938). However, Clariond also recognized the sedimentary cover on top of the Warzazate Supergroup with Cambrian trilobites. The latter formed the major source of Neltner's (1938) thesis.

Parallel investigations were undertaken in the rest of the succession. The extent of the Middle Cambrian (Acadian) became increasingly apparent through the evidence of the trilobites in the Anti-Atlas, the central High Atlas (Gigout 1937; Roch 1939), the eastern High Atlas (Menchikoff 1945a), the Jebilet (Gentil 1918; Barthoux 1924, 1926; Russo 1927; Roch 1930), the Rehamna (Le Villain 1931), and the Casablanca region (Lecointre 1918, 1926).

As a matter of historical practical constraints, the activities of geologists organized by the *Service Géologique du Maroc* dramatically decreased during World War II. Neltner continued field work. He prospected the Issafen valley and visited the now classical localities of the Souss valley together with Georges Choubert (1908–1986) during the winter of 1942–1943 (Choubert 1942, 1943). New publications on the Cambrian started after WWII with the reconnaissance trips and compilations of Georges Choubert (e.g., Choubert 1948) and with Neltner & Poctey (1947, 1950; Fig. 7). Choubert later dominated the stratigraphical research on the late Proterozoic and earliest Paleozoic in southern Morocco.

In 1949, Jean Abadie commenced with detailed investigations in the Tazemmourt section (close to Taroudannt, western Anti-Atlas). His intricate study of the section and the level-by-level col-

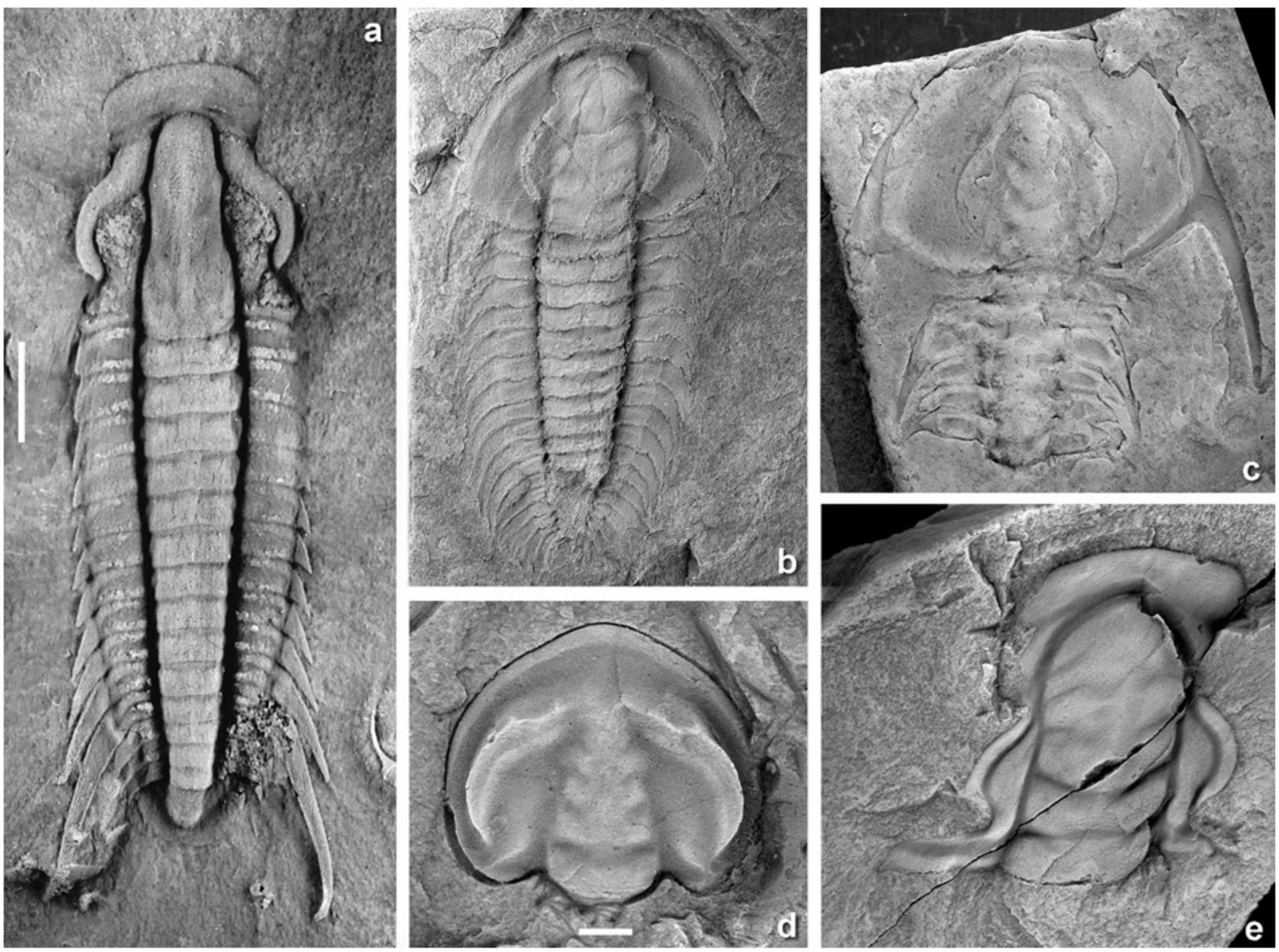

Fig. 7. Early published trilobites from the Neltner and Abadie collections of the western Anti-Atlas, Morocco. a, *Despujolsia rochi* Neltner & Poctey, 1949, holotype, MNHN.F.R50820, Amouslek section, figured by Neltner & Poctey 1949, pl. II, figs. 3, 4. b, *Bondonella typica* (Neltner & Poctey, 1949), holotype, MNHN.F.R 50865, Issafen syncline, figured by Neltner & Poctey 1949, pl. VI, fig. 1. c, *Fallotaspis longa* Hupé, 1953, MNHN.F.R50876, Amouslek section, figured as "*Olenellus bondoni*" in Neltner & Poctey 1949, pl. III, fig. 5. d, *Daguinaspis ambroggii* Hupé & Abadie, 1950, lectotype, MNHN.F.R50803a, Tazemmourt section. e, *Longianda termieri* (Neltner & Poctey, 1949), MNHN.F.R50912, Issafen Syncline, figure as *Callavia termieri* in Neltner & Poctey 1949, pl. I, fig. 4.

lection of the abundant trilobites (and archaeocyaths) became a first very detailed basis for fine-scale biostratigraphy (Hupé & Abadie 1950). This publication also included the description of *Daguinaspis ambroggii*, the first introduced fallotaspidid trilobite (Fig. 7c). Abadie's unpublished masters' thesis (Abadie 1950) and his collection were among the basic requirements for the monograph by Pierre Hupé (Hupé 1953). This unmatched "memoir" not only recorded a first biostratigraphical scheme for the lower Cambrian in the Moroccan Atlas ranges, but also provides a first detailed biostratigraphic subdivision of trilobite-bearing lower Cambrian strata (= Series 2) on a global scale.

Clearly, the High Atlas and particularly the Anti-Atlas received the focus on Cambrian trilobites research in the 1950s and the subsequent decades. The only noteworthy contribution for the Méséta in this time was Marcel Gigout's monographic thesis, with a comprehensive summary of Cambrian trilobites (Gigout 1951).

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Martin Basse, Peter Müller & Martin Müller

At the end of their article on the asteropygine trilobite *Psychopyge* from the Rupbach Shale, the authors cast speculations about future finds of complete specimens of this *Psychopyge*, which was hitherto known only by single parts of its carapace, except for one very incomplete, disarticulated specimen. While the article was in print, Martin Müller, son of Peter Müller, made all dreams come true by finding a virtually complete articulated specimen of *Psychopyge* n. sp. B (Figs. 1, 2) from the basal Rupbach Shale. This is the first proof of a complete articulated *Psychopyge* outside of Morocco. In almost touching the eighth, or ninth, axial ring of the thorax, the occipital spine of our find appears unusual among *Psychoypge*, in which the tip of the spine usually ends in a more or less clear distance from the axis, what in some cases may be result of incomplete preservation, or insufficient preparation. We speculate that this new condition was related to the molting process. When moving the head slightly upwards, the spine touched the axis and thus stabilized the cephalothorax which serves then as a kind of optimized abutment for the molting animal. It would be interesting to investigate well-preserved axial rings for a part possibly serving as counterpart for the tip of the spine. Such a construction appears to be useful in surroundings of soft muddy substrates as represented by the basal Rupbach Shales.

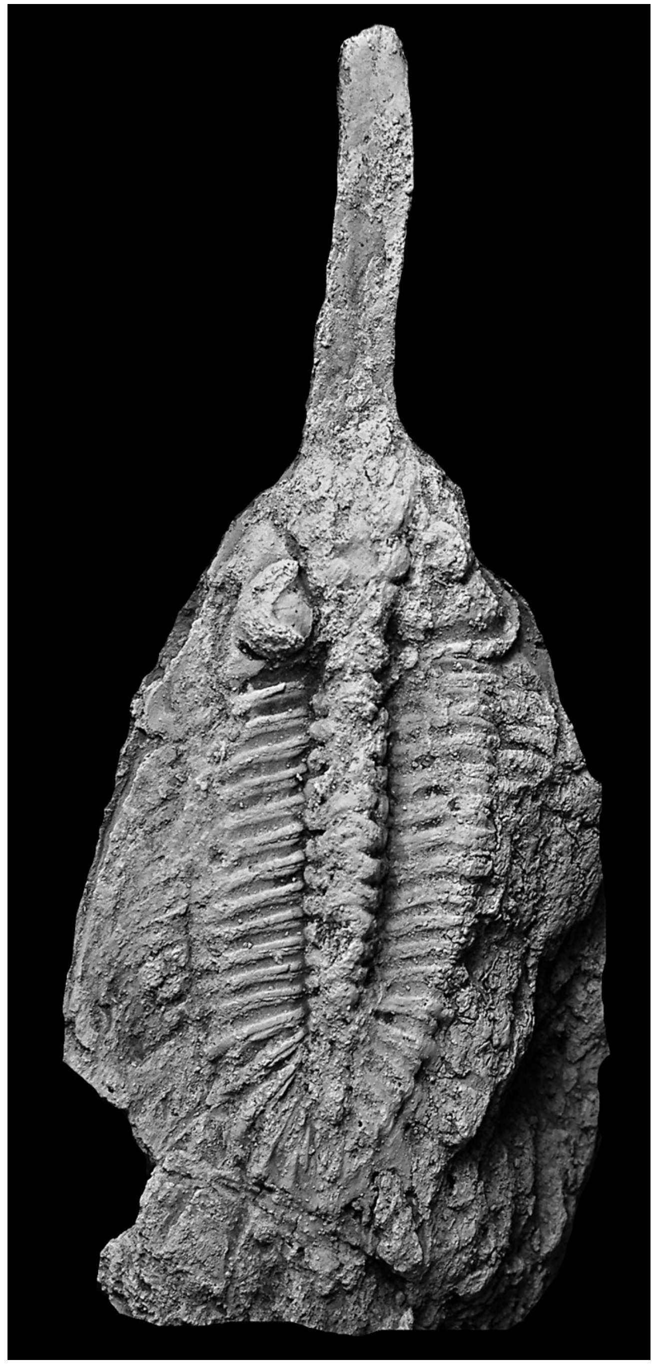

Figure 1. Internal mold of *Psychopyge* n. sp. B (of Basse & Müller 2019), quarry south of Steinsberg village (for details see Basse & Müller 2019: Fig. 1, right one of the two black lines), Lahn Syncline, Rhenish Massif, Germany. Rupbach Shale, middle Upper Emsian, late Early Devonian. Dorsal view. Length of specimen (from the tip of the anterior cephalic projection to the mesial point of the pygidial posterior margin): 62 mm. Collection M. Müller.

Figure 2. Next page

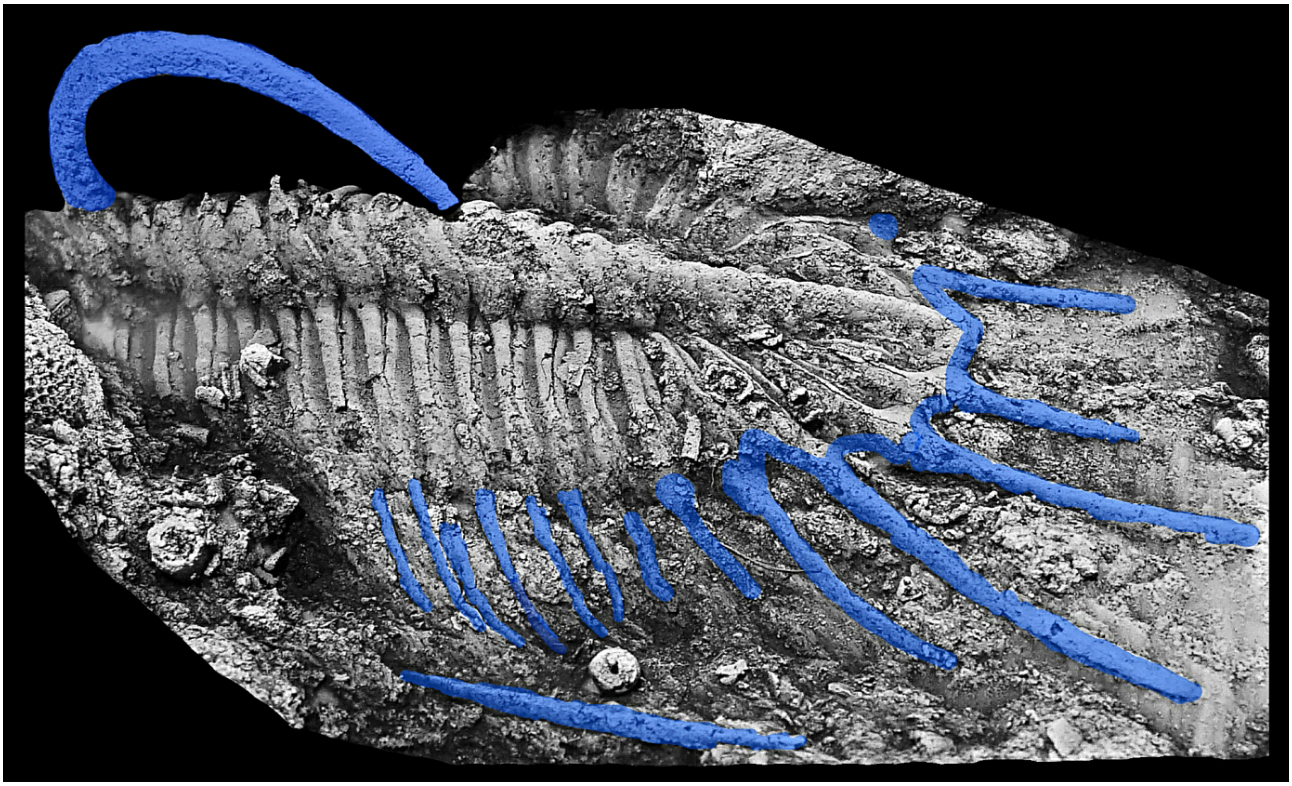

Figure 2. Cast of the incompletely preserved external mold of the same specimen in lateral view. Bluish: Occipital spine in full length almost touching one thoracic axial ring, part of left fixigenal spine, damaged pleural spines of thoracic segments five to eleven, and five more or less damaged long lateral pygidial spines and the very short mesial pygidial spine. (Photograph by P. Müller.)

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