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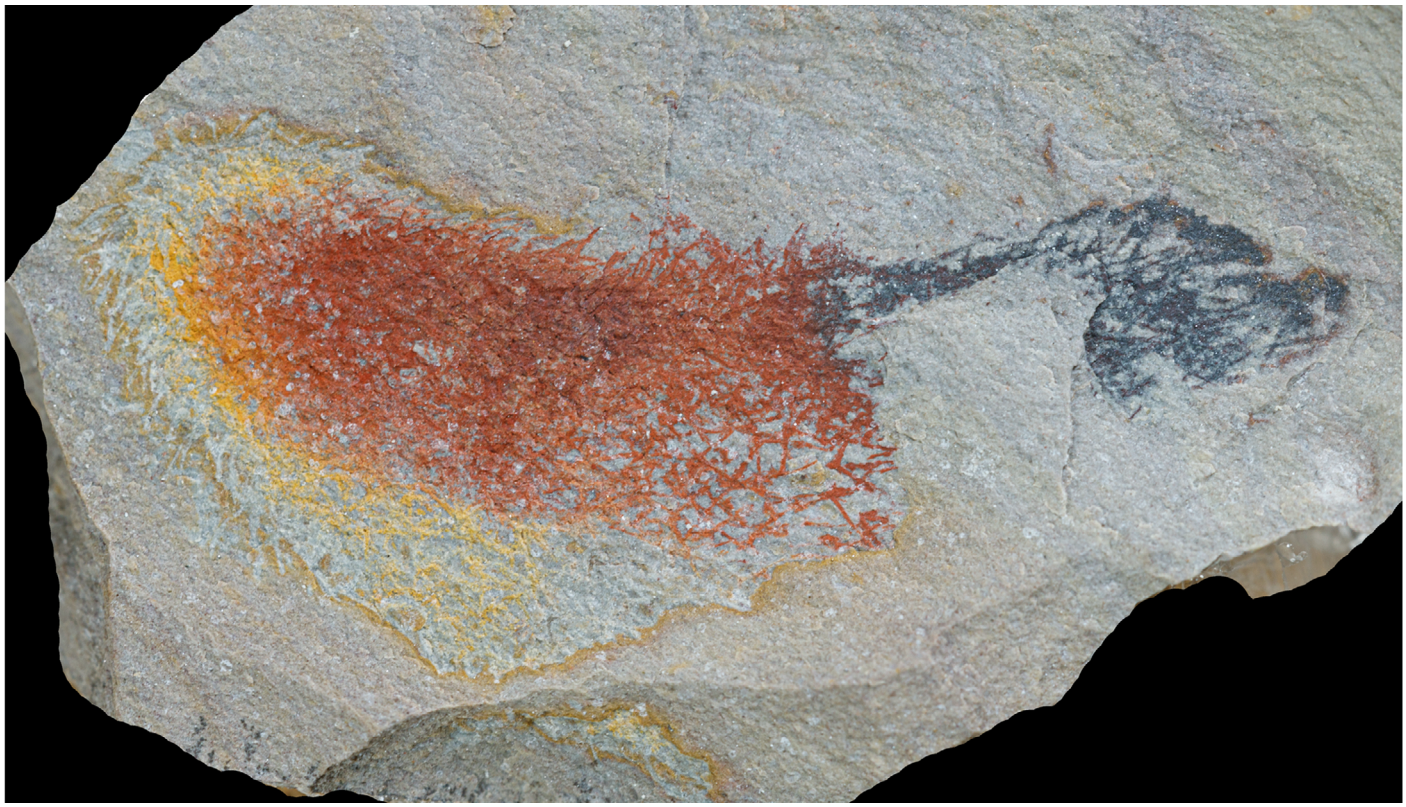

JOHN R. FOSTER, THOMAS F. HOWELLS, & STEVEN D. SROKA. 2022. First record of the chancelloriid *Allonnia* from the middle Cambrian Wheeler Formation (Drumian, Miaolingian) of western Utah

Cover: *Allonnia* cf. *Al. tintinopsis*, FHPR 11423, from the Wheeler Formation of western Utah.

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First record of the chancelloriid *Allonnia* from the middle Cambrian Wheeler Formation (Drumian, Miaolingian) of western Utah

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A newly described specimen of chancelloriid represents the first occurrence of *Allonnia* Doré and Reid, 1965 in the middle Cambrian Wheeler Formation of Utah. This occurrence fills a geographic gap in the distribution of the genus from the Burgess Shale Formation (British Columbia) to the Puerto Blanco and El Gavilán formations (Sonora). It is also the geologically youngest occurrence of the genus in North America.

Keywords: Chancelloriida, Cambrian, Wheeler Formation, Utah

INTRODUCTION

Chancelloriids are an enigmatic group of sponge-like animals of the early Paleozoic, represented by forms such as *Chancelloria* and *Archiasterella* Sdzuy 1969, collectively known from the Burgess Shale Formation (Canada), San Isidro Formation (Argentina), Kaili biota (China), Pioche Formation (United States), and numerous other formations of the Cambrian. The chancelloriid *Allonnia* is known from Cambrian units in Europe, Asia, Australia, Africa, and North America (Doré and Reid 1965; Sdzuy 1969; Elicki and Schneider 1992; Mehl 1998; Clausen and Álvaro 2006; Clausen et al. 2014; Moore et al. 2014; Bengtson and Collins 2015; Yun et al. 2017; Cong et al. 2018; Zhao et al. 2018; Beresi et al. 2019), with a possible occurrence in Antarctica (Wrona 2004). As sessile filter-feeders of broadly cylindrical body form, the chancelloriids are similar to sponges but differ in the structure of their hollow sclerites, which are only superficially like the spicules of sponges. .

The Wheeler Formation is a middle Cambrian unit in the West Desert region of western Utah (Fig. 1) preserving numerous fossil taxa ranging from trilobites and unmineralized arthropods to priapulids and echinoderms (Robison 1964; Gunther and Gunther 1981; Hintze and Davis 2003; Robison et al. 2015; Foster and Gaines 2016). Collections from the Wheeler Formation represent more than 115 species, dominated in species richness by trilobites, non-trilobite arthropods, sponges, and then brachiopods (in descending order); chancelloriids comprise just 2.5% of the species richness (Foster and Gaines 2016). Members of the benthic epifauna dominate the Wheeler Formation as well.

Although *Chancelloria* has been found in the Wheeler Formation (Robison et al. 2015; Foster and Gaines 2016), no other chancelloriid genera have been previously reported from the unit. Here, we report the first occurrence of the chancelloriid *Allonnia* in the Wheeler Formation.

MATERIALS AND METHODS

The specimen (FHPR 11423) was collected as surface material at the Red Wheeler (RAR 116) site in the Antelope Hills part of the House Range (Fig. 1). The specimen was studied with an Allied Fisher Scientific Stereomaster microscope and an FEI Quanta 600F scanning electron microscope and its associated software. Elemental spectral analysis was conducted with the SEM. Standard photography was by a Canon EOS Mark IV digital camera with a Laowa 100mm F2.8 CA-Dreamer Macro2X lens. Terminology used here is based on Moore et al. (2014, 2021).

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Institutional abbreviations

FHPR, Utah Field House of Natural History State Park Museum, Vernal, Utah; **KUMIP**, University of Kansas Museum of Invertebrate Paleontology, Lawrence, Kansas; **RAR**, prefix for locality numbers of Richard Robison.

SYSTEMATIC PALEONTOLOGY

CHANCELLORIDA Walcott, 1920
CHANCELLORIIDAE Walcott, 1920
ALLONIA Doré and Reid, 1965
ALLONIA cf. *AL. TINTINOPSIS*
Bengtson and Collins, 2015
Figs. 2 and 3

Referred specimen—FHPR 11423, scleritome.

Locality and Horizon—Red Wheeler Locality, south slope of Antelope Mountain, KUMIP site RAR 116 (Conway Morris and Robison 1988), House Range, Millard County, Utah (Fig. 1); upper Wheeler Formation, middle Cambrian (Drumian, Miaolingian; *Bolaspidella-Ptychagnostus atavus* zones, Peng et al. 2020). Precise locality data available for research projects from FHPR or KUMIP.

Description— The specimen is in a piece of thin, yellow-red (5YR 6/3) calcareous shale. The specimen is small at approximately 26 mm long by 12 mm wide, preserved as a scleritome that is partly covered by matrix near the apical end (Fig. 2A); basal to the matrix cover the sclerites are preserved in a moderate to bright orange color, due to iron mineralization (possibly limonite or hematite; Fig. 2B, 2C), whereas toward the apical end from the matrix cover, the sclerites are dark gray to black. The sclerites appear to be hematite- or limonite-replaced (Fig. 2B, 2C), which obscures some details of their morphology other than overall shape. The scleritome does not appear to be complete at the apical end, and there is no clear indication of the apical orifice tuft. The specimen was found on the surface, and no counterpart was located.

Sclerites are on average approximately 1.5 mm long vertically by 1.1 mm wide horizontally (Fig. 2A, 2B), though some longer individual rays are present on the more apical and basal (Fig. 2D) sclerites. Although the specimen is not particularly well preserved, there is no indication of central or principal rays within the sclerites (Fig. 3A), and the articulatory facets of the adapical horizontal rays suggest contact with just two abapical rays and not a principal ray also (Fig. 3B). Sclerites appear to be mostly in a 3+0, abaxially angled or curved arrangement of the rays, typical of *Allonnia* and not the 5–8+1 of most parts of *Chancelloria* nor the 4+0 of *Archiasterella* (Moore et al. 2014, 2021; Bengtson and Collins 2015; Yun et al. 2017).

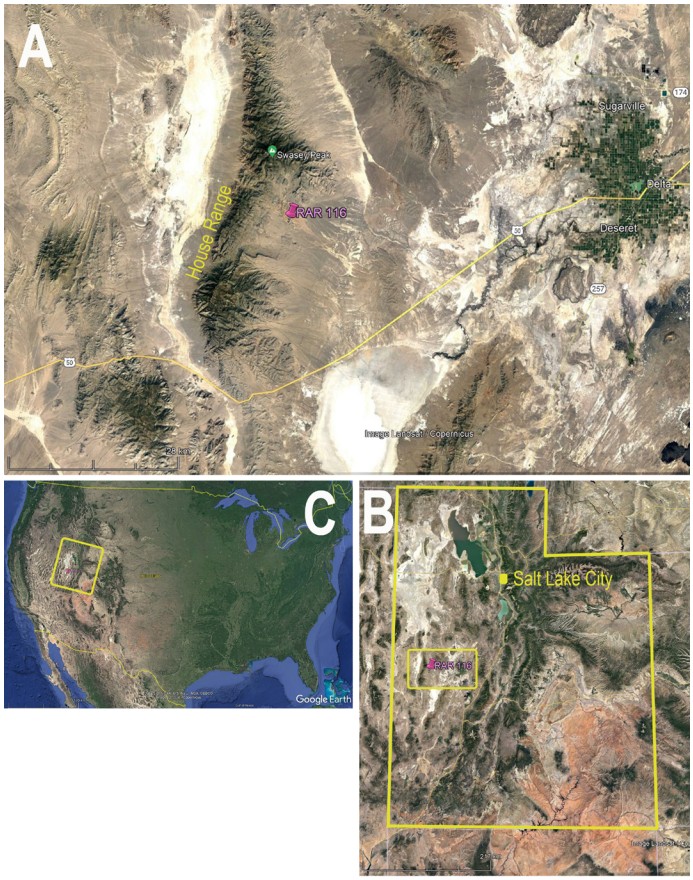

Figure 1. Location of the Red Wheeler locality (RAR 116, pink pin) in Utah's West Desert, west of Delta, Utah (A); within Utah (B); and in the western United States (C). All base maps from Google Earth, Map data ©2022 Google). Scales marked in lower left in A and B.

There is one area near the middle edge of the scleritome that spectral analysis revealed is elevated in carbon content. This area is not well differentiated by visible light but shows well by backscatter SEM imaging (Fig. 3C).

Some sclerites elsewhere on the scleritome are too poorly preserved to be certain of their arrangement, but sclerite rays near the apical and basal ends appear to be particularly elongate and demonstrate a range of preservation, including with low elemental contrast and as impressions in matrix (Fig. 3D, 3E). The covering of sclerites is even and dense along the length of the scleritome, although the sclerites do seem to increase in size somewhat apically and near the base.

The scleritome tapers gradually toward the base so that the overall shape appears to be broadly conical, as in *Allonnia erjiensis* Yun et al. 2017 from Chengjiang; the base is not a more elongate taper with few sclerites as in *Al. tenuis* Zhao et al. 2018 from the Wulongqing

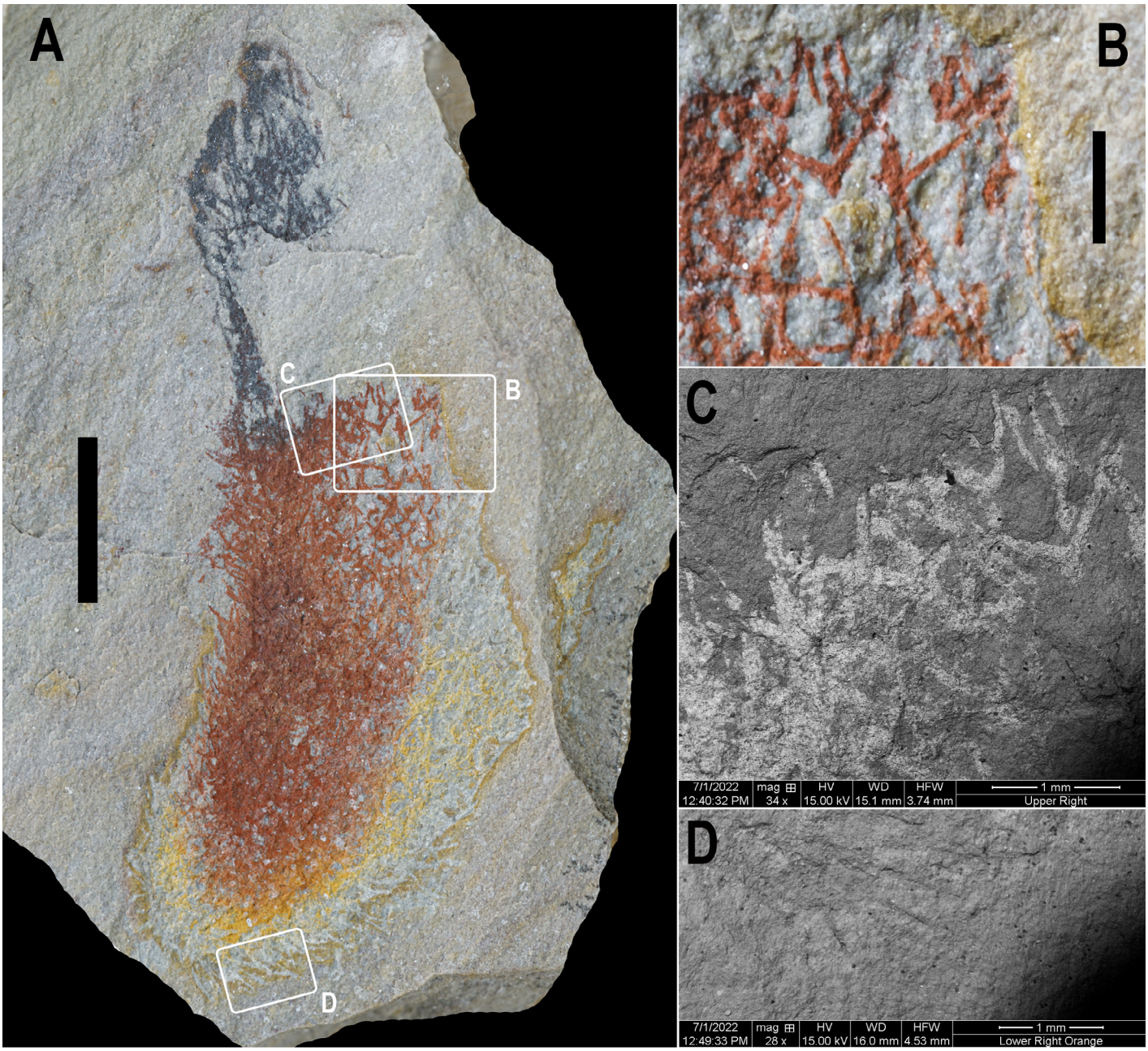

Figure 2. *Allonnia* cf. *Al. tintinopsis*, FHPR 11423, from the Wheeler Formation of western Utah. A) Scleritome with detail views in B, C, and D marked with white boxes, showing different preservational areas. Scale = 5 mm. B) Color detail of sclerites from middle of scleritome. Scale = 1 mm. C) SEM view showing contrast between matrix (dark gray) and high-iron sclerites (light). Scale = 1 mm. D) SEM view of basal area of scleritome showing multiple elongate sclerite rays. Scale = 1 mm.

Formation. FHPR 11423 differs from *Al. erjiensis*, however, in that the slightly larger, more apical sclerites appear to be just as densely distributed as near the base. FHPR 11423 also differs from *Al. nuda* Cong et al. 2018 and *Al. phrixothrix* Bengtson and Hou 2001 in having an overall denser distribution of sclerites than either of those taxa. The sclerites of FHPR 11423 show no evidence of the 4- to 5-rayed arrangement of *Al. tetrathallis* Moore et al. 2014. Sclerite rays of FHPR 11423 appear to be more robust than most specimens of *Al. tintinopsis* Bengtson and Collins 2015 but are more slender than *Al. erromenosa* Moore et al. 2014, as an example of a more robust-rayed form. The overall proportions and structure of the individual sclerites of FHPR 11423 are similar to those of *Archiasterella uncinata*, except that *Ar. uncinata* has mostly 4+0 sclerites with a principal ray as the fourth

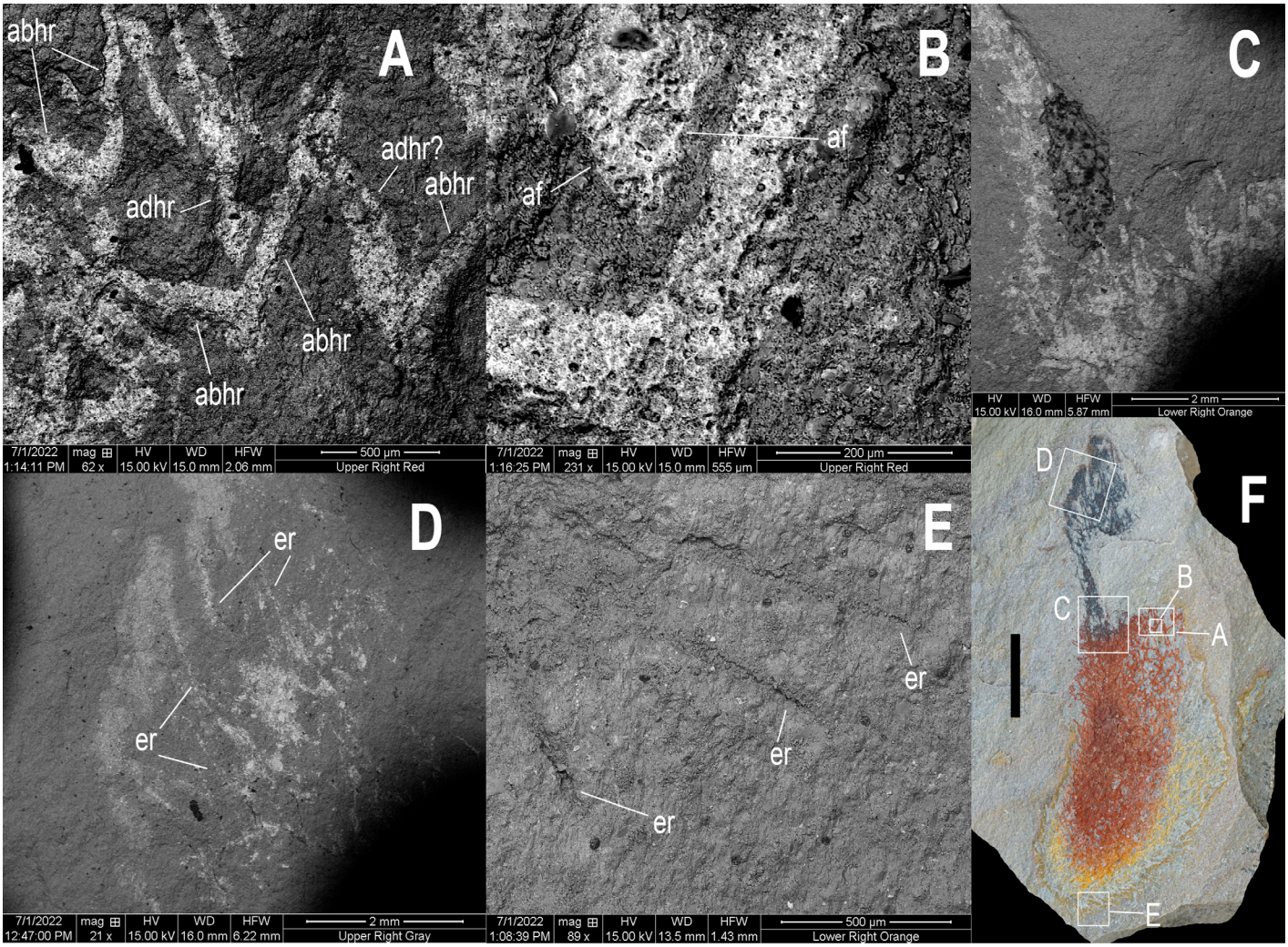

Figure 3. Details of *Allonnia* cf. *Al. tintinopsis*, FHPR 11423, from the Wheeler Formation of western Utah. A) SEM image of several sclerites, showing abapical and adapical horizontal rays and absence of central or principal rays, confirming 3+0 arrangement. B) SEM image of sclerite central in A, showing apparent articulatory facets on a displaced adapical horizontal ray between abapical horizontal rays of presumably the same sclerite. C) SEM image of oval-shaped area of high carbon content (dark gray to black) near transition between orange and dark gray preservation areas of the scleritome. D) SEM image of more apically-placed dark gray preservation area of scleritome showing apparent very elongate rays but relatively low elemental contrast between the fossil and matrix. E) SEM image of the basal part of the scleritome showing very elongate sclerite rays preserved as impressions in the matrix rather than by elemental contrast. F) View of scleritome with areas of details A–E indicated. Scale bar = 5 mm. Scale bars for A–E in each image. Abbreviations: **abhr**, abapical horizontal ray; **adhr**, adapical horizontal ray; **af**, articulatory facet; **er**, very elongate ray.

(Moore et al. 2021; e.g., fig. 15K). As noted above, principal rays appear to be absent in sclerites of FHPR 11423 .

DISCUSSION

FHPR 11423 is perhaps most similar in the overall shape of the scleritome, and in the shapes and evenness of distribution density of the sclerites, to *Al. tintinopsis* from the Burgess Shale Formation of British Columbia, the Puerto Blanco and El Gavilán formations of Sonora, and the Guojiaba Formation of China (Bengtson and Collins 2015; Beresi et al. 2019; Devaere et al. 2019; Yun et al. 2021). However, the sclerite rays of FHPR 11423 appear to be slightly more robust than those of most specimens of *Al. tintinopsis*. On the other hand, there appears to be some range of variation in the robustness or slenderness of rays in many specimens of *Allonnia*, *Chancelloria*, and *Archiasterella* (Bengtson and Collins 2015), and the apical and basal ends of FHPR 11423 do appear to have sclerites with much more elongate rays, thus making for slender sclerites in some areas. The

sclerites of FHPR 11423 may be within the ranges of variation of more than one species of *Allonnia* (*Al. tintinopsis* and *Al. erromenosa*). Because of the similarities of the scleritome shape and of the structure, distribution, and, to a slightly lesser degree, the slenderness of the sclerite rays, we tentatively identify the specimen as *Allonnia* cf. *Al. tintinopsis*.

FHPR 11423 represents the first occurrence of the genus *Allonnia* in the Wheeler Formation and indeed in the Cambrian of the western United States. All previous occurrences (and purported occurrences) of *Allonnia* in Laurentia have been in Greenland, western Canada, Mexico, or the eastern United States (Pennsylvania), and most are isolated sclerites, with the only other scleritome specimens having come from the Burgess Shale (Moore et al. 2021). The new *Allonnia* occurrence thus fills in a geographic gap between those in western Canada (Bengtson and Collins 2015) and Sonora, Mexico (Beresi et al. 2019; Devaere et al. 2019).

Chancelloriids of the Wheeler Formation previously included only *Chancelloria eros*, *C. pentacta*, and *Chancelloria* sp. (Rigby 1978; Janussen et al. 2002; Robison et al. 2015; Foster and Gaines 2016), and other Cambrian formations in the region of the western US include in their faunas only *Chancelloria* and/or *Archiasterella* (Moore et al. 2021). The occurrence of *Allonnia* in the region is thus new but not entirely unexpected.

In terms of stratigraphy, the Wheeler Formation spans the *Ptychagnostus gibbus–P. atavus* zones boundary, with approximately the upper half of the formation in the *P. atavus* zone (Babcock et al. 2007), this full range of the Wheeler Formation being equivalent to the upper *Ehmaniella* to *Bolaspidella* polymerid trilobite biozones of the Miaolingian. The chancelloriids from the Burgess Shale Formation occur in quarries that are likely within various subzones of the *Ehmaniella* biozone, which likely does not range as high as the base of the *Ptychagnostus atavus* zone (Morgan 2021). Therefore, FHPR 11423, from the upper Wheeler Formation well within the *P. atavus* zone (and thus also within the *Bolaspidella* biozone), likely represents the youngest occurrence of *Allonnia* in Laurentia so far. The formation is likely to produce more specimens of this relatively rare chancelloriid.

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LITERATURE CITED

Babcock, L.E., Robison, R.A., Rees, M.N., Peng, S., and Saltzman, M.R. 2007. The Global boundary Stratotype Section and Point (GSSP) of the Drumian Stage (Cambrian) in the Drum Mountains, Utah, USA. *Episodes* 30:85–95.

Bengtson, S., and Collins, D. 2015. Chancelloriids of the Cambrian Burgess Shale. *Palaeontologia Electronica* 18.1.6A: 1–67.

Bengtson, S., and Hou, X. 2001. The integument of Cambrian chancelloriids. *Acta Palaeontologica Polonica* 46:1–22.

Beresi, M.S., Buitrón-Sánchez, B., Cuen-Romero, and Palafox, J.J. 2019. Escleritomos de Chancelloria eros y escleritos del Cámbrico medio (Serie 3, Piso 5) de Sonora central, México. *Revista Mexicana de Ciencias Geológicas* 36:54–63.

Clausen, S., and Álvaro, J.J. 2006. Skeletonized microfossils from the Lower-Middle Cambrian transition of the Cantabrian Mountains, northern Spain. *Acta Palaeontologica Polonica* 51:223–238.

Clausen, S., Álvaro, J.J., and Zamora, S. 2014. Replacement of benthic communities in two Neoproterozoic-Cambrian subtropical-to-temperate rift basins, High Atlas and Anti-Atlas, Morocco. *Journal of African Earth Sciences* 98:72–93.

Cong, P.-Y., Harvey, T.H.P., Williams, M., Siveter, David J., Siveter, Derek J., Gabbott, S.E., Li, Y.-J., Wei, F., and Hou, X.-G. 2018. Naked chancelloriids from the lower Cambrian of China show evidence for sponge-type growth. *Proceedings of the Royal Society B* 285, DOI:10.1098/rsspb.2018.0296.

Conway Morris, S.C., and Robison, R.A. 1988. More soft-bodied animals and algae from the Middle Cambrian of Utah and British Columbia. *The University of Kansas Paleontological Contributions* 122:1–48.

Devaere, L., Clausen, S., Sosa-Leon, J.P., Palafox-Reyes, J.J., Buitrón-Sánchez, B.E., and Vachard, D. 2019. Early Cambrian small shelly fossils from northwest Mexico: biostratigraphic implications for Laurentia. *Palaeontologia Electronica* 22.2.41A:1-60.

Doré, F., and Reid, R.E. 1965. *Allonnia tripodophora* nov. gen., nov. sp., nouvelle Éponge du Cambrien inférieur de Carteret (Manche). *Compte Rendu Sommaire des Séances de la Société Géologique de France* 1:20–21.

Elicki, O., and Schneider, J. 1992. Lower Cambrian (Atdabanian/Botomian) shallow-marine carbonates of the Görlitz Synclinorium (Saxony/Germany). *Facies* 26:55–66.

Foster, J.R., and Gaines, R.R. 2016. Taphonomy and paleoecology of the "middle" Cambrian (Series 3) formations in Utah's West Desert: recent finds and new data. *Utah Geological Association Publication* 45:291–336.

Gunther, L.F., and Gunther, V.G. 1981. Some Middle Cambrian fossils of Utah. *Brigham Young University Geology Studies* 28:1–81.

Hintze, L.F., and Davis, F.D. 2003, Geology of Millard County, Utah. *Utah Geological Survey Bulletin* 133, 305 p.

Janussen, D., Steiner, M., and Maoyan, Z. 2002. New well-preserved scleritomes of Chancelloridae from the Early Cambrian Yuanshan Formation (Chengjiang, China) and the Middle Cambrian Wheeler Shale (Utah, USA) and paleobiological implications. *Journal of Paleontology* 76:596–606.

Mehl, D. 1998. Porifera and Chancelloriidae from the Middle Cambrian of the Georgina Basin, Australia. *Palaeontology* 41:1153–1182.

Moore, J.L., Li, G., and Porter, S.M. 2014. Chancelloriid sclerites from the lower Cambrian (Meishucunian) of eastern Yunnan, China, and the early history of the group. *Palaeontology* 57:833–878.

Moore, J.L., Porter, S.M., Webster, M., and Maloof, A.C. 2021. Chancelloriid sclerites from the Dyeran–Delamaran ("Lower–Middle" Cambrian) boundary interval of the Pioche-Caliente region, Nevada, USA. *Papers in Palaeontology* 7 part 1:565–623.

Morgan, C.A. 2021. Quantitative trilobite biostratigraphy of the middle Cambrian (Wuliuan Stage; Miaolingian Series) and microfacies analysis of the middle Cambrian Stephen Formation, southern Canadian Rocky Mountains. Unpublished PhD dissertation, University of Calgary, 445 p.

Peng, S.C., Babcock, L.E., and Ahlberg, P. 2020. The Cambrian Period. Pp. 565–629 in Gradstein, F.M., Ogg, J.G., Schmitz, M.D., and Ogg, G.M. (eds.) Geologic Time Scale 2020 volume 2. Elsevier, Amsterdam.

Rigby, J.K. 1978. Porifera of the Middle Cambrian Wheeler Shale, from the Wheeler Amphitheater, House Range, in western Utah. *Journal of Paleontology* 52:1325–1345.

Robison, R.A. 1964. Late Middle Cambrian faunas from western Utah. *Journal of Paleontology* 38:510–566.

Robison, R.A., Babcock, L.E., Gunther, V.G., 2015. Exceptional Cambrian fossils from Utah: a window into the age of trilobites. *Utah Geological Survey Miscellaneous Publication* 15-1:1–97.

Sdzuy, K. 1969. Unter- und mittelkambrische Porifera (Chancelloriida und Hexactinellida). *Paläontologische Zeitschrift* 43:115–147.

Walcott, C.D. 1920. Cambrian geology and paleontology IV No. 6 – Middle Cambrian Spongiae. *Smithsonian Miscellaneous Collections* 67:261–364.

Wrona, R. 2004. Cambrian microfossils from glacial erratics of King George Island, Antarctica. *Acta Palaeontologica Polonica* 49:13–56.

Yun, H., Zhang, X., and Li, L. 2017. Chancelloriid *Allonnia erjiensis* sp. nov. from the Chengjiang Lagerstätte of South China. *Journal of Systematic Palaeontology* 16:435–444. DOI:10.1080/14772019.2017.1311380.

Yun, H., Cui, L., Li, L., Liu, W., and Zhang, X. 2021. Pyritized preservation of chancelloriids from the Cambrian Stage 3 of South China and implications for biomineralization. *Geobios* 69:77–86.

Zhao, J., Li, G.-B., and Selden, P.A. 2018. New well-preserved scleritomes of Chancelloriida from early Cambrian Guanshan Biota, eastern Yunnan, China. *Journal of Paleontology* 92:955–971. DOI:10.1017/jpa.2018.43.