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Trilobites from the *Cedaria prolifica* Zone (Cambrian, upper Guzhangian) of the Precordillera of Mendoza, western Argentina

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Abstract.—Trilobites from the upper Guzhangian of the southern Argentine Precordillera, preliminarily described by Carlos Rusconi in the 1950s, are revised herein. The specimens studied were collected from an allochthonous limestone block of La Cruz Olistoliths at 200 m northwest of Estancia San Isidro locality (San Isidro area, Mendoza). Taxa comprise *Kormagnostus seclusus* (Walcott, 1884), *Cedaria prolifica* Walcott, 1924, *C. puelchana* Rusconi, 1954, *Tricrepicephalus texanus* (Shumard, 1861), *Meteoraspis metra* (Walcott, 1890), *Coosia conicephala* (Rusconi, 1954) new combination, *Coosella texana*? Resser, 1942, *Nasocephalus* cf. *N. nasutus* Wilson, 1954, and *Olenoides proa* (Rusconi, 1954) new combination. The North American genera *Meteoraspis* Resser, 1935 and *Nasocephalus* Wilson, 1954 are reported confidently from South America for the first time. This assemblage is representative of the *Cedaria prolifica* Zone, which correlates with the lower *Crepicephalus* Zone of the traditional North American genus-based zonation. Most of the genera and species identified were previously described exclusively from Canada, the United States, and northwestern Mexico, a fact that provides new support to an allochthonous Laurentian origin of the Argentine Precordillera.

Introduction

During the 1940s and 1950s, the naturalist Carlos Rusconi described large numbers of Cambrian trilobites from the southern Precordillera of Mendoza, western Argentina (Rusconi, 1956a and references therein; Cerdeño, 2005). Many of these fossils were collected from the San Isidro area (Fig. 1), where early Miaolingian to late Furongian exotic limestone blocks (San Isidro, San Martín, and La Cruz olistoliths) occur within Middle and Upper Ordovician shales (Bordonaro et al., 1993; Keller, 1999). It is now recognized that Cambrian trilobites from the Argentinian Precordillera have clear Laurentian affinities. Recent systematic revisions of the Rusconi collections provided updated information on several standard North American trilobite zones such as the *Glossopleura walcotti*, *Ehmaniella*, *Lejopyge laevigata*, *Elvinia* and *Saukia* zones (Tortello and Bordonaro, 1997; Bordonaro, 2003, 2014; Bordonaro and Fojo, 2011; Pratt and Bordonaro, 2014; Tortello, 2018, 2020, 2022).

In addition, the Rusconi collections include numerous specimens from the *Cedaria*/*Crepicephalus* Zone (Rusconi, 1954; Borrello, 1965, 1971) that have yet to be revised. These specimens come from 200 m northwest of Estancia San Isidro (Fig. 1) and were partially described by Rusconi (1954, p. 47, pl. 4, figs. 1–14), who pointed out the presence of the key genera *Cedaria* Walcott, 1924 and *Tricrepicephalus* Kobayashi, 1935. Although Rusconi (1954) erected several local species from this assemblage, Pratt (1992) synonymized some of them with *Tricrepicephalus texanus* (Shumard, 1861), a taxon that is known from the *Cedaria* and *Crepicephalus* zones of many regions of North America. Furthermore, Robison (1988) and Tortello and Bordonaro (1997) reported, with some reservation, the agnostoid *Kormagnostus seclusus* (Walcott, 1884) from this locality.

Aside from the specimens described by Rusconi (1954), many supplementary sclerites collected by Rusconi from 200 m northwest of Estancia San Isidro are available for study in the Museo de Ciencias Naturales y Antropológicas "Juan Cornelio Moyano" of Mendoza City. A comprehensive systematic revision of this material is presented here. Along with *Tricrepicephalus*, *Coosia* Walcott, 1911, and *Coosella* Lochman, 1936, the genera *Meteoraspis* Resser, 1935 and *Nasocephalus* Wilson, 1954 are reported confidently from South America for the first time. In addition, specimens of *Cedaria* are of considerable biostratigraphic value and reinforce the Laurentian affinity of the fauna. Most of the genera and species identified were previously described exclusively from North America, a fact that provides new support for an allochthonous origin of the Argentine Precordillera (Ramos et al., 1986; Astini et al., 1995; Keller, 1999; Martin et al., 2020 and references therein).

Geologic setting

The Estancia San Isidro locality (Fig. 1) was discovered by Carlos Rusconi and Manuel Tellechea (Museo J. C. Moyano) in the 1950s (Rusconi, 1954, 1957) and was subsequently referred to by Borrello (1965) as an isolated section cropping out in a "complex geologic setting." Fossils occur together in a limestone that is now regarded as part of La Cruz Olistoliths (=La Cruz Limestones sensu Keller, 1999), which are represented by a few

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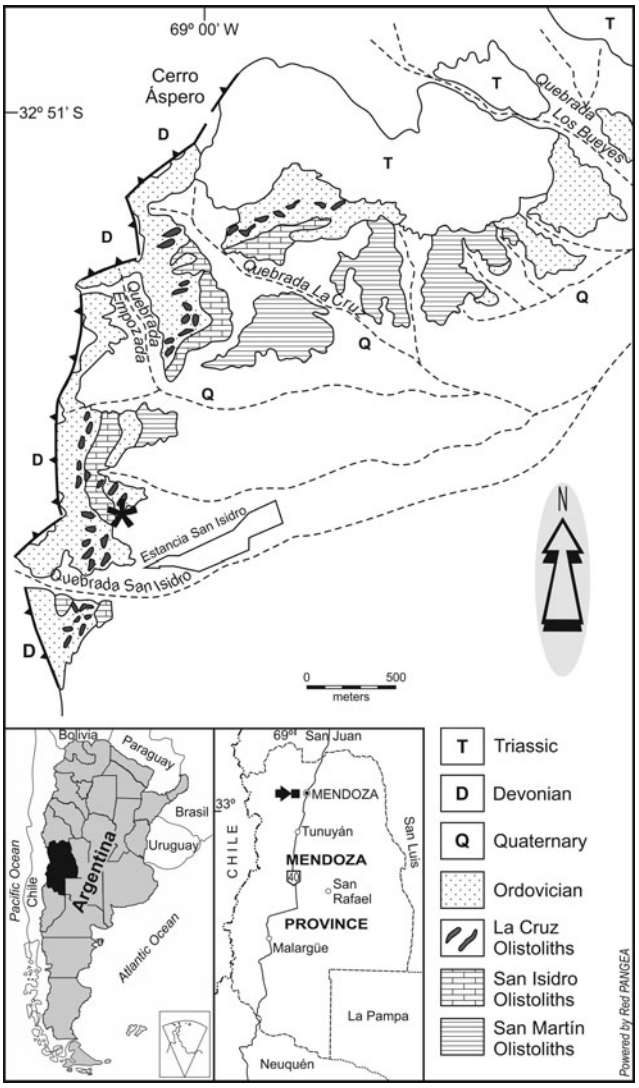

Figure 1. Map of the San Isidro area, Mendoza Province, Argentina (after Bordonaro et al., 1993 and Tortello, 2022). The 200 m northwest of Estancia San Isidro locality is indicated by an asterisk.

centimeters to several meters thick carbonate blocks containing late Miaolingian and Furongian open-marine faunas, emplaced in Middle and Upper Ordovician shales of the Estancia San Isidro and Empozada formations. Full information on the geology of the San Isidro area was provided by Bordonaro et al. (1993), Heredia (1995), Bordonaro and Banchig (1996), Keller (1999), Bordonaro (2003), Heredia and Beresi (2004), and Ortega et al. (2007).

Biostratigraphy

The most representative trilobites from the Estancia San Isidro locality were originally described by Rusconi (1954) as *Tricrepicephalus anarusconii* Rusconi, 1954, *T. nahuelus* Rusconi, 1954, *T.*? *serranus* Rusconi, 1954, *Coosella convexa* Rusconi, 1954, and *Cedaria puelchana* Rusconi, 1954. Rusconi (1954) first regarded this assemblage as latest middle Cambrian or earliest late Cambrian in age, and then Borrello (1965, 1971, p. 407, tables 1, 2) assigned it to the North American *Crepicephalus* Zone (Guzhangian) pointing out the occurrence of *T. anarusconii* Rusconi, 1954 (see also Rusconi, 1956b, 1962, 1967; Wilson, 1957, fig. 2; Furque and Cuerda, 1979, p. 461). Later, Pratt (1992) considered *T. anarusconii*, *T. nahuelus* and *T.*? *serranus* as junior synonyms of *T. texanus* (Shumard, 1861).

The assemblage from San Isidro as revised here comprises *Kormagnostus seclusus* (Walcott, 1884), *Cedaria prolifica* Walcott, 1924, *C. puelchana* Rusconi, 1954, *Tricrepicephalus texanus* (Shumard, 1861), *Meteoraspis metra* (Walcott, 1890), *Coosia conicephala* (Rusconi, 1954), *Coosella texana*? Resser, 1942, *Nasocephalus* cf. *N. nasutus* Wilson, 1954, and *Olenoides proa* (Rusconi, 1954).

Olenoides has limited value in biostratigraphy because of its exceptionally long stratigraphic range. Apart from its rare records from Central Asia, China, and Antarctica, this genus is well known from Wuliuan, Drumian, and Guzhangian strata of North America, from the *Albertella* Zone to the *Cedaria*/*Crepicephalus* Zone. In the Guzhangian of Quebec and Tennessee, it was recorded in association with *Kormagnostus seclusus* (Rasetti, 1946, 1965).

Kormagnostus seclusus is a common species of the *Cedaria* and *Crepicephalus* faunas of North America, occurring in different lithofacies (e.g., Palmer, 1954a, b; Robison, 1988 and references therein; Pratt, 1992 and references therein; Stitt and Perfetta, 2000). In shallow, unrestricted neritic deposits, it is commonly the only agnostoid of the assemblages (Robison, 1988). *Kormagnostus seclusus* has a stratigraphic range from at least the lower *Lejopyge laevigata* Zone to the *Glyptagnostus stolidotus* Zone. In addition to North America, it was described from Sakhayan and Nganasanian horizons of Siberia (Rosova, 1964), the *Kormagnostus simplex* (=*K. seclusus*) Zone of Kazakhstan (Ergaliev, 1980), and the *Lejopyge laevigata* Zone of the Precordillera of San Juan and the northern Precordillera of Mendoza, Argentina (Poulsen, 1960; Robison, 1988; Bordonaro and Liñán, 1994; Tortello, 2011).

As stated by Palmer (1954b), *Tricrepicephalus texanus* is a recurrent constituent of the *Coosella* Zone and its equivalents in Laurentian North America. As revised by Pratt (1992), this species is present in assemblages from the upper *Cedaria* and *Crepicephalus* zones at numerous localities in the United States, Canada, and Sonora (Mexico) (e.g., Lochman and Duncan, 1944; Palmer, 1954b; Sundberg and Cuen-Romero, 2021). In the Rabbitkettle Formation of northwestern Canada, *T. texanus* was documented throughout the uppermost *Cedaria minor*, *C. selwyni*, *C. prolifica*, and *C. brevifrons* zones (Pratt, 1992).

In addition, *Coosella texana* is known from the *C. selwyni* Zone of the Rabbitkettle Formation (Pratt, 1992) and from the *Crepicephalus* Zone of the Warrior Formation, Pennsylvania (Tasch, 1951), in both cases in association with *Tricrepicephalus texanus*. Likewise, *Meteoraspis metra* occurs in the *Coosella* Zone from the Riley Formation of Texas (Walcott, 1890; Lochman, 1938a; Palmer, 1954b) and in the lower *Crepicephalus* Zone from the lower Deadwood Formation of South Dakota (Stitt and Perfetta, 2000).

Cedaria prolifica Walcott, 1924 is the most abundant species in the fauna studied and provides precise age information as it is known from the eponymous zone of northwest Canada, as well as from the partially equivalent *Crepicephalus* Zone of British Columbia, Alabama, and Tennessee (Resser, 1938;

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Palmer, 1962; Pratt, 1992). On the basis of the preceding discussion, the assemblage is assigned to the *C. prolifica* Zone, which correlates with the lower *Crepicephalus* Zone of the traditional North American genus-based zonation (e.g., Lochman-Balk and Wilson, 1958; Robison, 1964a; Pratt, 1992, text-fig. 19; Westrop et al., 1996, fig. 6).

An additional reference to the *Crepicephalus* Zone in Argentina was provided by Vaccari (1996), who reported *Crepicephalus* Kobayashi, 1935, *Coosella* Lochman, 1936, *Pemphigaspis* Hall, 1863, and *Madarocephalus* Resser, 1938 from La Flecha Formation of the Precordillera of La Rioja and San Juan (see also Benedetto et al., 2009).

Materials and methods

Materials and preservation.—The collection studied consists of disarticulated specimens that are preserved mostly as testate or partly exfoliated sclerites. Before photography, the material was coated with magnesium oxide smoke from burning magnesium ribbon. To give a full picture of the morphology of the exoskeleton, some specimens are illustrated in dorsal, lateral, and frontal views.

Repository and institutional abbreviation.—The specimens examined in this study are housed in the Museo de Ciencias Naturales y Antropológicas "Juan Cornelio Moyano" (Mendoza City, Argentina) with the prefix MCNAM.

Systematic paleontology

Terminology.—The morphological terms used in the following have been defined mostly by Whittington and Kelly (1997), with additional terminology from Shergold et al. (1990) for the agnostoid trilobites. The following abbreviations are used: sag., sagittally; exsag., exsagittally; long., longitudinally; tr., transversally.

Order Agnostida Salter, 1864
Family Ammagnostidae Öpik, 1967
Genus *Kormagnostus* Resser, 1938

Type species.—*Agnostus seclusus* Walcott, 1884 from the Guzhangian of Tennessee (by synonymy with *Kormagnostus simplex* Resser, 1938; see Robison, 1988).

Remarks.—Palmer (1954a), Robison (1988), Shergold et al. (1990), Peng and Robison (2000), and Westrop and Adrain (2013) discussed in detail the scope of *Kormagnostus* Resser, 1938. This genus is characterized mainly by having an effaced anteroglabella, a well-defined to partially effaced pygidial axial furrow, a wide (tr.), elongate, parallel-sided or posteriorly expanded pygidial axis reaching posterior border furrow, weak to effaced transaxial furrows, and broad cephalic and pygidial marginal furrows. As stated by Westrop and Adrain (2013), the closely related genus *Kormagnostella* Romanenko *in* Romanenko and Romanenko, 1967 is distinguished by showing an extremely effaced pygidium, a narrower, well-incised pygidial border furrow, and a broad and convex pygidial border and by lacking posterolateral spines throughout holaspid ontogeny.

Kormagnostus seclusus (Walcott, 1884)
Figure 2.1, 2.2

1884 *Agnostus seclusus* Walcott, p. 25, pl. 9, fig. 14.
1954 *Kormagnostus cuchillensis* Rusconi, p. 48, text-fig. 25.
1988 *Kormagnostus seclusus* (Walcott); Robison, p. 45, fig. 11.5–11.15 (see for further synonymy).
1992 *Kormagnostus seclusus*; Pratt, p. 31, pl. 3, figs. 1–3, 14–29 (see for further synonymy).
1997 *Kormagnostus seclusus*; Tortello and Bordonaro, p. 78, fig. 3.12–3.17 (see for further synonymy).
2000 *Kormagnostus seclusus*; Stitt and Perfetta, p. 203, fig. 6.1–6.4.
2011 *Kormagnostus seclusus*; Tortello, p. 118, fig. 2C, D, G.

Holotype.—Cephalon (U.S. National Museum 24586) from the Hamburg Limestone, Eureka District, Nevada (Walcott, 1884, pl. 9, fig. 14; Palmer, 1954a, pl. 13, fig. 1).

Occurrence.—Widespread in the Guzhangian of the United States (e.g., Nevada, Utah, Texas, Missouri, Tennessee, South Dakota, Wyoming, Montana), northwest and eastern Canada, Greenland, western Argentina, Kazakhstan, and Siberia (e.g., Palmer, 1954a, b; Rosova, 1964; Ergaliev, 1980; Robison, 1988 and references therein; Pratt, 1992 and references therein; Tortello and Bordonaro, 1997 and references therein; Peng and Robison, 2000, p. 35; Stitt and Perfetta, 2000; Tortello, 2011).

Remarks.—Robison (1988) was the first to suggest the occurrence of *Kormagnostus seclusus* (Walcott, 1884) at the Estancia San Isidro locality, regarding it as a possible senior synonym of *Kormagnostus cuchillensis* Rusconi, 1954, which was later endorsed by Tortello and Bordonaro (1997). Unfortunately, the holotype of *K. cuchillensis* is an incomplete pygidium (Tortello and Bordonaro, 1997, fig. 3.17). In addition, a paratype pygidium (not figured previously) and a supplementary cephalon are illustrated herein. These sclerites are characterized by an effaced anteroglabella; a median glabellar node centered on the posteroglabella; a rounded glabellar culmination; smooth, anteriorly confluent genae; a broad, subparallel-sided pygidial axis surrounded by faint axial furrows; a small axial tubercle; and a slightly constricted pygidial acrolobe. Although the pygidial border is imperfectly preserved and thus it is not possible to determine the presence or absence of posterolateral spines, the morphology of the specimens conforms well with *K. seclusus* (Walcott, 1884), a highly variable species that is known from the Guzhangian of various regions of Laurentia, in addition to Kazakhstan and Siberia. Palmer (1954a, b), Robison (1988), Pratt (1992), and Peng and Robison (2000) discussed in detail the synonymy and scope of *K. seclusus*. As in the case of some exfoliated cephala described from North America (e.g., Palmer, 1954b, pl. 76, fig. 8; Lochman and Hu, 1960, pl. 99, figs. 9, 17; Pratt, 1992, text-fig. 26A; Westrop

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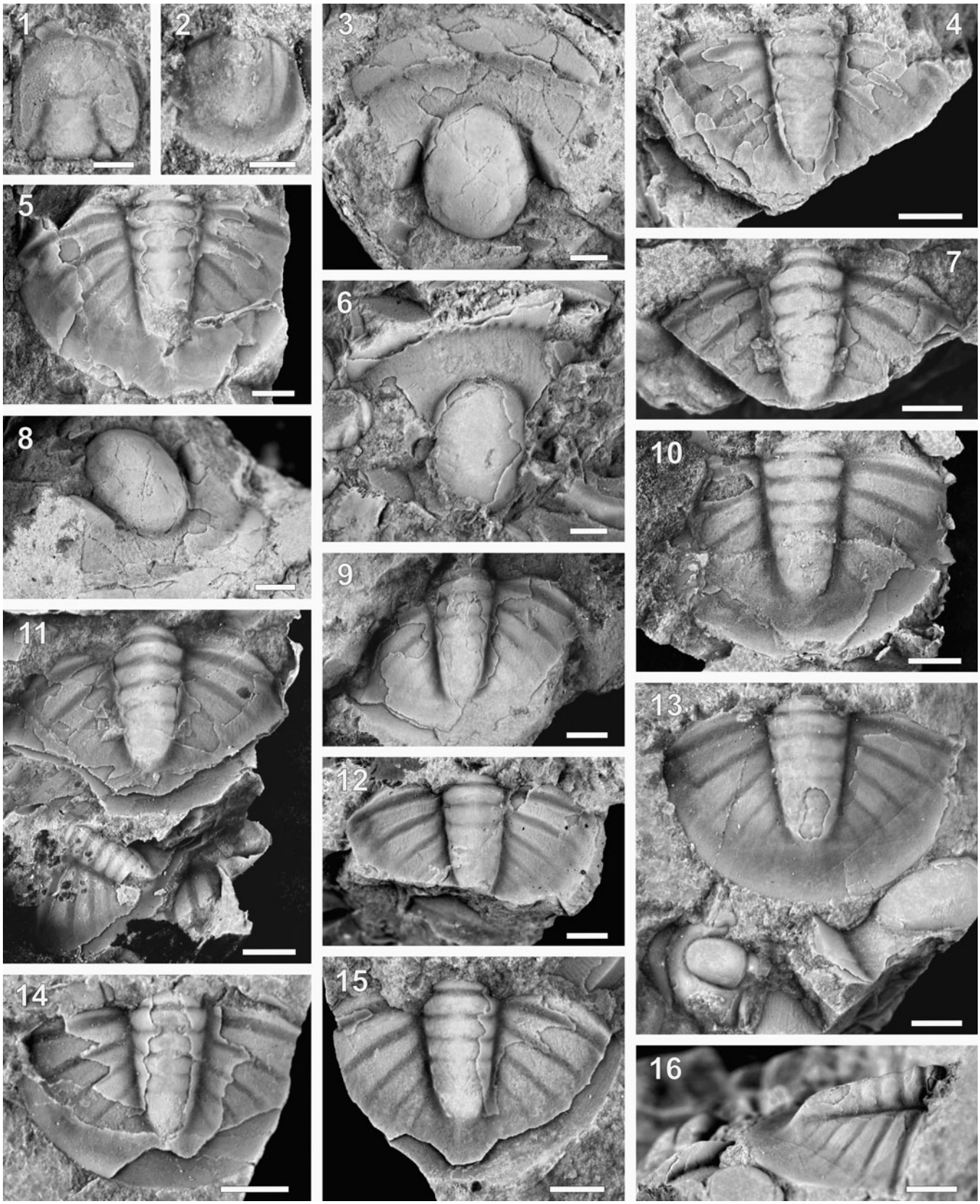

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Figure 2. (**1, 2**) *Kormagnostus seclusus* (Walcott, 1884): (**1**) mostly exfoliated cephalon, MCNAM 17795; (**2**) testate pygidium, MCNAM 17369, *Kormagnostus cuchillensis* Rusconi, 1954 paratype (not illustrated previously). (**3–16**) *Cedaria prolifica* Walcott, 1924: (**3, 8**) mostly exfoliated cranidium in dorsal (**3**) and oblique (**8**) views, MCNAM 17374, *Tricrepicephalus anarusconii* Rusconi, 1954 paratype (illustrated previously by Rusconi, 1954, pl. 4, fig. 4); (**4**) partially exfoliated pygidium, MCNAM 17440; (**5**) partially testate pygidium, MCNAM 17425, *Cedaria puelchana* Rusconi, 1954 paratype (illustrated previously by Rusconi, 1954, pl. 4, fig. 10); (**6**) partially exfoliated cranidium, MCNAM 17397 (previously assigned to *Cedaria puelchana* by Rusconi, 1954, p. 52); (**7**) mostly exfoliated pygidium, MCNAM 17429; (**9**) latex cast of partially testate pygidium, MCNAM 18794; (**10**) latex cast of mostly exfoliated pygidium, MCNAM 17426; (**11**) latex cast of mostly exfoliated pygidium, MCNAM 17932; (**12**) testate pygidium, MCNAM 17439; (**13, 16**) mostly testate pygidium (top) and two fragmentary cranidia (bottom) in dorsal (**13**) and lateral (**16**) views, MCNAM 17769; (**14**) partially exfoliated pygidium, MCNAM 17441; (**15**) mostly exfoliated pygidium, MCNA 17428. *Cedaria prolifica* Zone of San Isidro, Mendoza. (**1, 2**) Scale bars = 1 mm; (**3–16**) scale bars = 2 mm.

et al., 1996, fig. 13.15; Stitt and Perfetta, 2000, fig. 6.1, 6.2), the material from San Isidro shows slight indications of a subtriangular anterior glabellar lobe.

As stated by Pratt (1992), *Kormagnostus seclusus* differs from *K. robisoni* Pratt, 1992 from the *Cedaria selwyni* Zone of the Rabbitkettle Formation, northwest Canada (Pratt, 1992, pl. 3, figs. 30–36, text-fig. 26C), because the latter has an elongate pygidium that is subtrapezoidal in outline, a bulb-shaped posteroaxis, and a markedly constricted pygidial acrolobe. *Kormagnostus flati* Pratt, 1992 from the *Cedaria brevifrons* Zone of the Rabbitkettle Formation, northwest Canada, and the *Crepicephalus* Zone of the Pilgrim Formation, Montana (Lochman and Duncan, 1944, pl. 5, figs. 15, 16; Pratt, 1992, pl. 2, figs. 27–33, text-fig. 26B), is slightly differentiated from *K. seclusus* in the more anterior location of the median glabellar node, the wider (tr.) pygidial axis, and the unconstricted pygidial acrolobe.

Order Ptychopariida Swinnerton, 1915
Family Cedariidae Raymond, 1937
Genus *Cedaria* Walcott, 1924

Type species.—*Cedaria prolifica* Walcott, 1924, from the upper Guzhangian of Alabama, by original designation.

Remarks.—Palmer (1962) and Pratt (1992) discussed in detail the morphology of *Cedaria* Walcott, 1924, which is followed here. As pointed out by Pratt (1992), it is a genus of Cedariidae with an anteriorly rounded subrectangular glabella, a moderately long (sag.) anterior border, divergent anterior facial sutures, palpebral lobes located at glabellar midlength, and a semicircular to transversely semielliptical pygidium.

Cedaria prolifica Walcott, 1924
Figures 2.3–2.16, 3.1–3.3

1924 *Cedaria prolifica* Walcott, p. 55, pl. 10, fig. 6.
1925 *Cedaria prolifica*; Walcott, p. 79, pl. 17, figs. 18–21.
1938 *Cedaria prolifica*; Resser, p. 67, pl. 11, figs. 1, 2, 6, 7.
1954 *Tricrepicephalus anarusconii* Rusconi (part), p. 49, pl. 4, fig. 4 (only; figs. 2, 3, *Tricrepicephalus texanus*).
1954 *Cedaria puelchana* Rusconi (part), p. 52, pl. 4, fig. 10 (only).
1962 *Cedaria prolifica*; Palmer, p. 26, pl. 3, figs. 9, 10, 14–16, 20, pl. 6, fig. 14.
1992 *Cedaria prolifica*; Pratt, p. 80, pl. 30, figs. 1–4 (see for further synonymy).

Lectotype.—Complete exoskeleton (U.S. National Museum 70266) from the Conasauga Formation, Cedar Bluff, Cherokee County, Alabama (Walcott, 1925, pl. 17, fig. 28; Pratt, 1992, p. 80).

Occurrence.—Alabama, Conasauga Formation; Tennessee, Nolichucky Formation; British Columbia, northern Rocky Mountains; Northwest Canada, Rabbitkettle Formation (Walcott, 1925; Resser, 1938; Palmer, 1962; Fritz, 1970; Pratt, 1992). 200 m northwest of Estancia San Isidro, San Isidro area, Mendoza, La Cruz Olistoliths, *Cedaria prolifica* Zone.

Remarks.—These specimens represent a species of *Cedaria* with a strongly divergent anterior facial suture; a moderately convex anterior border; a distinct anterior border furrow constituted by a row of medium-sized pits; a preglabellar field subequal in length (sag.) to longer than cranidial border, with variably expressed caecate prosopon; a semicircular pygidium with axis bearing five to six axial ring furrows; pleural fields showing a deep anterior border furrow and four pairs of distinctive, widely spaced pleural furrows; and a moderately broad pygidial border. Following the diagnoses of Palmer (1962) and Pratt (1992), the material can be confidently assigned to *Cedaria prolifica* Walcott, 1924. Although there are only a few fragmentary cranidia available for study, they show strongly divergent anterior branches of the facial suture, which is one of the most characteristic features of the species. Variations in the sagittal length of the preglabellar field and the degree of expression of the caecate prosopon were also documented by Palmer (1962) and Resser (1938), respectively. As in other species of *Cedaria*, the relative length of the preglabellar field seems to increase during holaspid ontogeny.

One of the cranidia examined (MCNAM 17374, *Tricrepicephalus anarusconii* Rusconi, 1954 paratype; Rusconi, 1954, pl. 4, fig. 4) (Fig. 2.3, 2.8) was referred questionably to *Cedaria selwyni* Pratt, 1992 by Pratt (1992; and later discussions in Bordonaro and Banchig, 1996; Bordonaro, 2003; Sundberg, 2018); however, its anterior facial suture seems to be strongly divergent, and therefore a reassignment to *C. prolifica* is preferred herein. Likewise, a *C. puelchana* Rusconi, 1954 paratype pygidium (MCNAM 17425, Rusconi, 1954, pl. 4, fig. 10) and one cranidium questionably referred to *C. puelchana* by Rusconi (1954, p. 52) are reillustrated here (Fig. 2.5, 2.6) and reassigned to *C. prolifica*.

Cedaria prolifica and *C. minor* (Walcott, 1916), from the upper Guzhangian of Utah, northwestern Canada, and Greenland (Pratt, 1992 and references therein), exhibit similar pygidia, but the latter species is distinguished by having less-divergent anterior sections of the facial suture, a flat anterior cranidial border, and a shallower anterior border furrow in which pits are absent or faint (Pratt, 1992).

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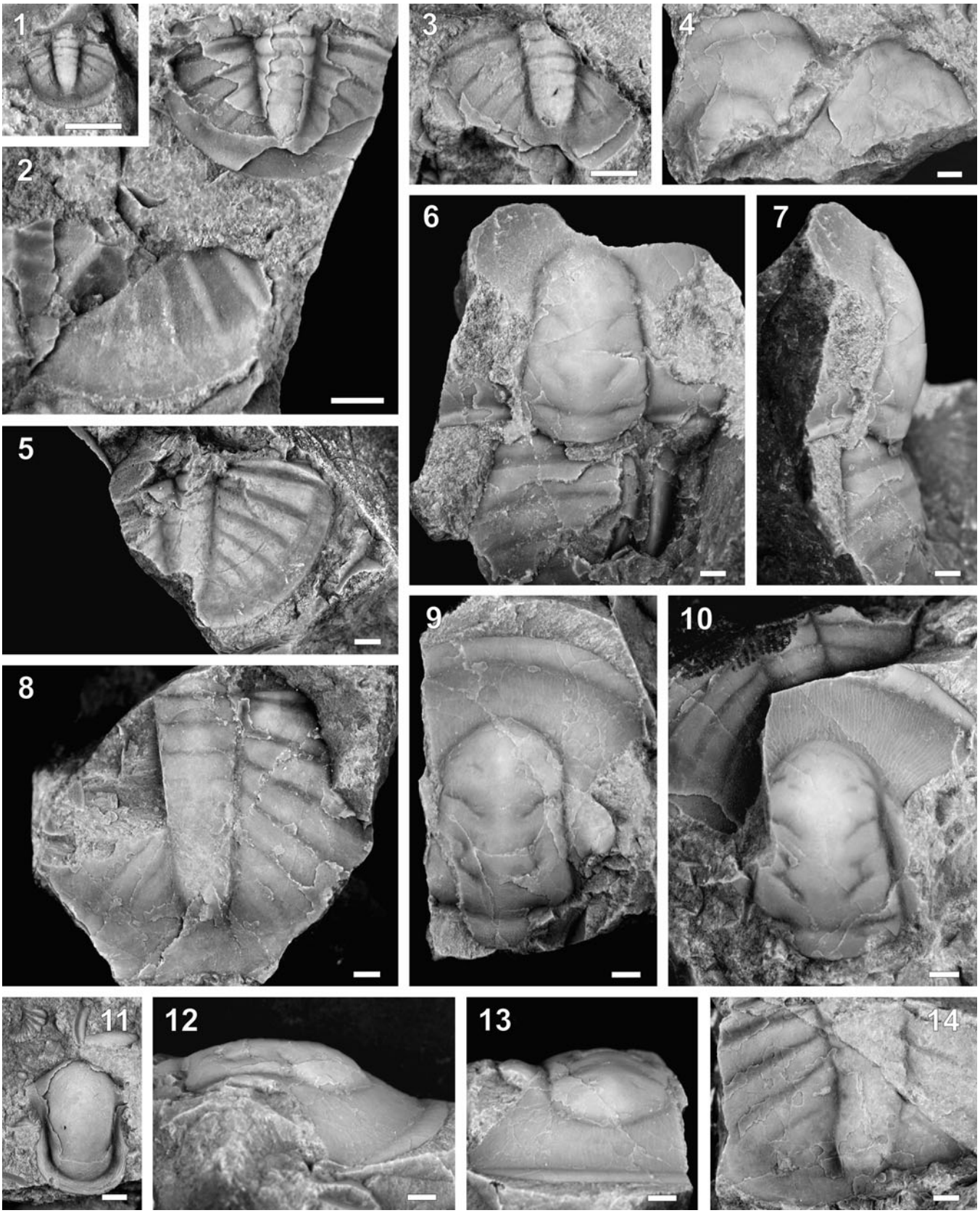

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Figure 3. (**1–3**) *Cedaria prolifica* Walcott, 1924: (**1**) small, exfoliated pygidium, MCNAM 17778; (**2**) partially exfoliated pygidium (top) (see also Fig. 2.14) and pygidial external mold (bottom), MCNAM 17441; (**3**) exfoliated pygidium, MCNAM 17791. (**4–14**) *Cedaria puelchana* Rusconi,1954: (**4**) cranidial and pygidial fragments, MCNAM 18780; (**5**) exfoliated pygidium, MCNAM 17424, *Cedaria puelchana* Rusconi, 1954 holotype (illustrated previously by Rusconi, 1954, pl. 4, fig. 9); (**6, 7**) partially testate cranidium and pygidial fragment in dorsal (**6**) and lateral (**7**) views, MCNAM 17457; (**8**) partially exfoliated pygidium, MCNAM 17790; (**9, 12, 13**) mostly exfoliated cranidium in dorsal (**9**), lateral (**12**), and anterior (**13**) views, MCNAM 18781; (**10**) exfoliated cranidium and fragmentary pygidium, MCNAM 17774; (**11**) mostly exfoliated hypostome (in association with a helcionelloid mollusk, top), MCNAM 17794; (**14**), partially testate pygidium, MCNAM 17770. *Cedaria prolifica* Zone of San Isidro, Mendoza. Scale bars = 2 mm.

Cedaria gaspensis Rasetti, 1946, from the *Crepicephalus* fauna of Gaspé, Quebec (Rasetti, 1946, pl. 67, figs. 26–29), differs from *C. prolifica* mainly by bearing a larger number of pygidial axial rings and pleural furrows. *Cedaria selwyni* Pratt, 1992, from the eponymous zone of Northwest Canada and Nevada (Pratt, 1992, pl. 31, figs. 9–16, text-fig. 31B; Sundberg, 2018, fig. 18.1–18.7), is differentiated by its effaced pygidium.

Cedaria puelchana Rusconi, 1954
Figure 3.4–3.14

1954 *Cedaria puelchana* Rusconi, p. 52, pl. 4, fig. 9 (only; fig. 10, *Cedaria prolifica*).

Holotype.—Pygidium (MCNAM 17424) from La Cruz Olistoliths, 200 m northwest of Estancia San Isidro, Mendoza (Rusconi, 1954, pl. 4, fig. 9; Fig. 3.5).

Diagnosis.—A species of *Cedaria* with a large exoskeleton; noticeable lateral glabellar furrows; strongly divergent anterior branches of the facial suture; a well-developed preglabellar field that is much longer (sag.) than cranidial border; elevated palpebral lobes lacking palpebral furrows; and a semicircular pygidium with a narrow (tr.), long pygidial axis composed of 7–8 rings, five pairs of distinct pleural furrows, and a slender border.

Occurrence.—Two hundred meters northwest of Estancia San Isidro, San Isidro area, Mendoza; La Cruz Olistoliths, *Cedaria prolifica* Zone.

Description.—Cranidium slightly convex, with broadly curved anterior margin and somewhat downsloping preglabellar field, maximum width between palpebral lobes ~70% (estimated) of total cranidial length; glabella of moderate size, subrectangular in outline, longer than wide, little elevated above genal region, occupying about three-quarters of total cranidial length (sag.) and 55% of cranidial width (tr.) at level of abaxial tip of S2, slightly constricted at L3, rounded to weakly pointed anteriorly, delimited by narrow axial and preglabellar furrows; maximum glabellar width at L1; L0 smooth or with faint indications of a delicate occipital node, broadly rounded posteriorly, representing ~13% of total glabellar length; S0 transglabellar, deeper, and fairly sinuous at sides and shallow and straight on midline; L1 much longer (exsag.) than L0, occupying ~22–25% of total glabellar length; lateral glabellar furrows S1–S4 faint but distinct, oblique backward, disconnected at middle; S2 and S4 weaker than S1 and S3; a supplementary furrow is sagittally extended from S1 to S2; anterior cranidial border narrow (sag.), weakly convex, of nearly constant breadth (sag., exsag.), bounded by a shallow border furrow that contains closely spaced pits; preglabellar field well developed, much longer (sag.) than anterior border, slightly downsloping, crossed by radiating prosopon ridges; anterior facial suture strongly divergent; ocular ridge delicate, oblique backward; palpebral area of the fixigena narrow (tr.); palpebral lobe arcuate, elevated, situated slightly behind cranidial midpoint, lacking palpebral furrow, extended from the level of S1 to the level of S3, occupying ~20% of the total cranidial length (sag.); posterior fixigena broadened outward, with shallow posterior border furrow and slightly convex, narrow (exsag.) posterior border; external surface of cuticle smooth or delicately granulated. Largest observed cranidium 22 mm long (sag.).

A relatively large hypostome is tentatively assigned to this species. It is suboval in outline, longer than wide, with subtriangular anterior wings, a gently convex median body, a short (sag.) and posteriorly rounded posterior lobe, and a moderately wide, depressed marginal border of uniform width, which exhibits subparallel terrace lines.

Pygidium semicircular in outline, somewhat convex transversely and longitudinally, wider than long, with entire margin; axis long and narrow, hardly tapered backward, scarcely elevated above level of pleural fields, surrounded by narrow axial furrows, with marked anterior three rings and faint or indistinct posterior four or five rings, ending in blunt terminal piece reaching marginal border; articulating half-ring narrow (sag.), crescentic; anterior border furrow deep, delimiting a narrow (exsag.) anterior border; pleural fields wide (tr.), weakly convex, crossed by five straight to slightly curved, oblique pleural furrows ending at level of marginal border; lateral and posterior border narrow, scarcely convex, bounded by a weak border furrow; in largest specimens, the border furrow is hardly represented by a change in slope of exoskeleton. Largest observed pygidium 21 mm long (sag.).

Remarks.—Rusconi (1954) described *Cedaria puelchana* on the basis of one holotype pygidium (MCNAM 17424) (Fig. 3.5), one paratype pygidium (MCNAM 17425) (Fig. 2.5), and one cranidium (MCNAM 17397) (Fig. 2.6). The latter two sclerites are reassigned in the preceding to *C. prolifica*, and a new set of cranidia is described herein for *C. puelchana*.

Cedaria puelchana has a certain resemblance to *Proceratopyge* Wallerius, 1895 in glabellar shape, appearance of the glabellar furrows, and position of the eyes, but the latter clearly differs by possessing a spinose pygidium. The cranidium of *Cedaria puelchana* compares most closely with that of specimens of *Cedaria* showing indications of arcuate lateral glabellar furrows (e.g., Lochman and Hu, 1962, pl. 2, figs. 1, 13; Robison, 1988, fig. 14.9), although it is differentiated by its more-divergent anterior facial suture.

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Cedaria puelchana also resembles *C. prolifica* Walcott, 1924, but the latter is distinguished mainly by its effaced glabella and its more transverse, less semicircular pygidium. In addition, *C. gaspensis* Rasetti, 1946, from the upper Guzhangian of Quebec (Rasetti, 1946, pl. 67, figs. 26–29), further differs by having a larger number of pygidial pleural furrows.

A fragmentary pygidium from the *Cedaria selwyni* Zone of Nevada (Sundberg, 2018, fig. 18.13) has similitude with *C. puelchana*, but it exhibits a narrower (tr.) pleural field.

Family Tricrepicephalidae Palmer, 1954

Remarks.—Palmer (1954b) provided diagnoses of the Guzhangian genera *Tricrepicephalus* Kobayashi, 1935 and *Meteoraspis* Resser, 1935 (see also Lochman, 1938b) and included them in the family Tricrepicephalidae, concepts that are followed here.

Genus *Tricrepicephalus* Kobayashi, 1935

Type species.—*Arionellus* (*Bathyurus*) *texanus* Shumard, 1861 from the upper Guzhangian of the United States, by original designation.

Tricrepicephalus texanus (Shumard, 1861)
Figure 4

1861 *Arionellus* (*Bathyurus*) *texanus* Shumard, p. 218.
1954b *Tricrepicephalus texanus* (Shumard); Palmer, p. 755, pl. 81, fig. 9 (see for further synonymy).
1954 *Tricrepicephalus anarusconii* Rusconi (part), p. 49, pl. 4, figs. 2, 3 (only; fig. 4, *Cedaria prolifica*).
1954 *Tricrepicephalus nahuelus* Rusconi, p. 50, pl. 4, fig. 5.
1954 *Tricrepicephalus*? *serranus* Rusconi, p. 51, pl. 4, fig. 6.
1954 *Coosella convexa* Rusconi, p. 51, pl. 4, figs. 7, 8.
1963 *Tricrepicephalus anarusconii*; Castellaro, p. 34, text-fig. (pygidium only).
1992 *Tricrepicephalus texanus*; Pratt, p. 62, pl. 21, figs. 1–7 (see for further synonymy).
2021 *Tricrepicephalus texanus*; Sundberg and Cuen-Romero, p. 7, fig. 5a–g (see for further synonymy).

Neotype.—Cranidium (U.S. National Museum 91865) from Potatotop Hill, seven miles northwest of Burnet, Burnet County, Texas (U.S.N.M. loc. 67-a) (Lochman, 1936, pl. 9, fig. 27).

Occurrence.—Southern Mackenzie Mountains, Northwest Canada, *Cedaria minor* Zone to *Cedaria brevifrons* Zone (Pratt, 1992). Western Newfoundland, eastern Canada, *Crepicephalus* Zone (Kindle, 1982). Widespread in United States (South Dakota, Wyoming, Utah, Nevada, Arizona, Texas, Missouri, Pennsylvania, Tennessee, Alabama), *Cedaria* and *Crepicephalus* zones (e.g., Palmer, 1954b and references therein; Pratt, 1992 and references therein); Sonora, Mexico, *Crepicephalus* Zone (Sundberg and Cuen-Romero, 2021 and references therein); San Isidro area, western Argentina, *Cedaria prolifica* Zone (Pratt, 1992; this paper).

Remarks.—*Tricrepicephalus texanus* (Shumard, 1861) is a species with a high range of morphological variability involving mainly cranidial surface granulation and length and shape of the anterior border. Palmer (1954b) and Pratt (1992) discussed in detail the scope of this taxon. According to the broad species concept of Pratt (1992) and Sundberg and Cuen-Romero (2021), *T. texanus* exhibits variably developed granules on the cranidium, and its extended synonymy includes, among others, *T. coria* (Walcott, 1916).

As stated in the preceding, *T. anarusconii* Rusconi, 1954 (Fig. 4.19, 4.20, holotype), *T. nahuelus* Rusconi, 1954 (Fig. 4.15, holotype), and *T.*? *serranus* Rusconi, 1954 (Fig. 4.17, holotype) from 200 m northwest of Estancia San Isidro were synonymized with *T. texanus* by Pratt (1992). Likewise, several additional specimens from the Rusconi collection, including cranidia with thickly granulated (e.g., Fig. 4.1–4.3, 4.5, 4.6), slightly granulated (Fig. 4.12), or smooth (e.g., Fig. 4.11) glabellae, are herein referred to *T. texanus*. Among these specimens, two cranidia (holotype and paratype) and one librigenal fragment (Fig. 4.1–4.6) were originally described as *Coosella convexa* Rusconi, 1954 by Rusconi (1954, p. 51, pl. 4, figs. 7, 8) (see preceding synonymy). Intraspecific variation in the material studied also involves the convexity of the anterior border, which is slightly convex (Fig. 4.11) or flat (Fig. 4.7, 4.13), the degree of expression of the pits in the marginal furrow (e.g., compare Fig. 4.1 with Fig. 4.11), and the general outline of the glabella.

The hypostome of *T. texanus* is seldom illustrated in the literature. As previously shown by Lochman in Lochman and Duncan (1944, pl. 5, fig. 3), it is characterized by having a convex, granulated median body (Fig. 4.14). This sclerite is suboval in outline, with a rounded anterior margin and a narrow, concave lateral border of uniform width, which is clearly delimited by a distinct border furrow. Maculae are well impressed, running backward with an angle of ~45°. Posterior lobe and border lack granulation.

Tricrepicephalus texanus differs from *T. tripunctatus* (Whitfield, 1876) because the latter bears a conspicuous occipital spine (e.g., Palmer, 1954b; Pratt, 1992; Stitt and Perfetta, 2000).

Genus *Meteoraspis* Resser, 1935

Type species.—*Ptychoparia*? *metra* Walcott, 1890 from the upper Guzhangian of Texas, by original designation.

Meteoraspis metra (Walcott, 1890)
Figure 5.1–5.15

1890 *Ptychoparia*? *metra* Walcott, p. 273, pl. 21, fig. 7.
1935 *Meteoraspis metra* (Walcott); Resser, p. 41.
1938a *Meteoraspis metra*; Lochman, pl. 17, fig. 1–3.
1954b *Meteoraspis metra*; Palmer, p. 753, pl. 82, figs. 2, 4 (see for further synonymy).
1954 *Meteoraspis tinguirensis* Rusconi, p. 55.
2000 *Meteoraspis metra*; Stitt and Perfetta, p. 212, fig. 9.16–9.19.

Holotype.—Cranidium (U.S. National Museum 23858) from Potatotop Hill, six miles northwest of Burnet, Burnet County,

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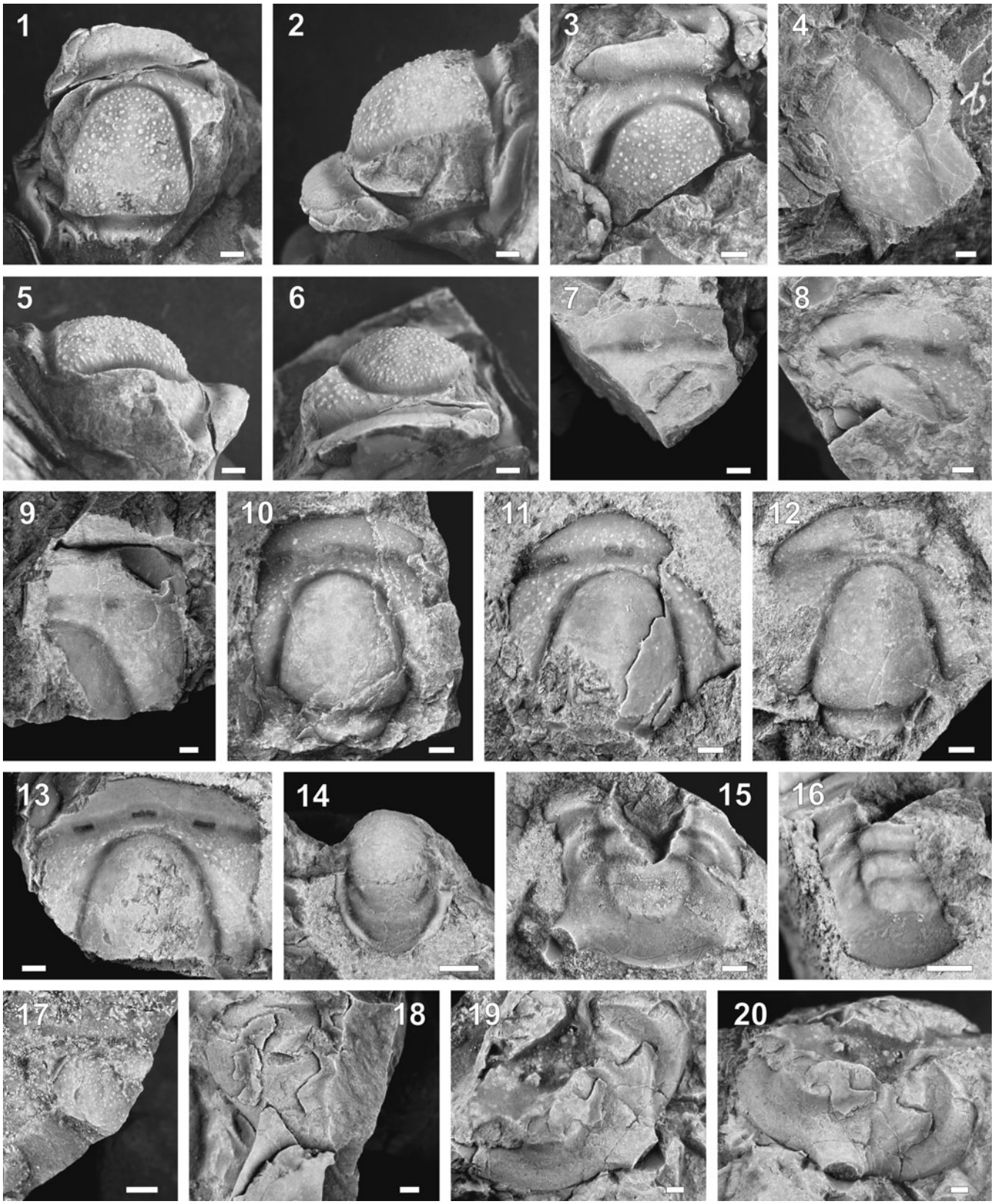

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Figure 4. *Tricrepicephalus texanus* (Shumard, 1861): (**1, 2, 5, 6**) exfoliated cranidium in dorsal (**1**), lateral (**2, 5**), and anterior (**6**) views, MCNAM 17393, *Coosella convexa* Rusconi, 1954 holotype (illustrated previously by Rusconi, 1954, pl. 4, fig. 7); (**3**) incomplete exfoliated cranidium, MCNAM 17392, *Coosella convexa* Rusconi, 1954 paratype (illustrated previously by Rusconi, 1954, pl. 4, fig. 8); (**4**) mostly exfoliated librigenal fragment, MCNAM 17362; (**7**) exfoliated cranidial fragment, MCNAM 17377; (**8**) exfoliated fragmentary cranidium, MCNAM 17376; (**9**) exfoliated fragmentary cranidium, MCNAM 17452; (**10**) mostly exfoliated cranidium, MCNAM 17454; (**11**) mostly exfoliated cranidium, MCNAM 17504; (**12**) exfoliated cranidium, MCNAM 17583; (**13**) mostly exfoliated cranidium, MCNAM 18784; (**14**) exfoliated hypostome, MCNAM 17557; (**15**) exfoliated pygidium, MCNAM 17380, *Tricrepicephalus nahuelus* Rusconi, 1954 holotype (illustrated previously by Rusconi, 1954, pl. 4, fig. 5); (**16**) exfoliated fragmentary pygidium, MCNAM 17756; (**17**) poorly preserved cranidium, MCNAM 17388, *Tricrepicephalus serranus* Rusconi, 1954 holotype (illustrated previously by Rusconi, 1954, pl. 4, fig. 6); (**18**) mostly exfoliated pygidium, MCNAM 17382; (**19, 20**) mostly exfoliated pygidium in dorsal (**19**) and lateral (**20**) views, MCNAM 17379, *Tricrepicephalus anarusconii* Rusconi, 1954 holotype (illustrated previously by Rusconi, 1954, pl. 4, fig. 2). *Cedaria prolifica* Zone of San Isidro, Mendoza. Scale bars = 2 mm.

Texas (Walcott, 1890, pl. 21, fig. 7; Lochman, 1938a, pl. 17, figs. 1–3).

Occurrence.—Burnet County, Central Texas, Riley Formation, *Coosella* Zone (Walcott, 1890; Lochman, 1938a; Palmer, 1954b); Black Hills, South Dakota, lower Deadwood Formation, lower *Crepicephalus* Zone (Stitt and Perfetta, 2000); 200 m northwest of Estancia San Isidro, San Isidro area, Mendoza, upper Guzhangian, La Cruz Olistoliths, *Cedaria prolifica* Zone.

Remarks.—Rusconi (1954, p. 55) first reported *Meteoraspis* Resser, 1935 from the Estancia San Isidro as *M. tinguirensis* Rusconi, 1954, which was based on one isolated pygidium (holotype MCNAM 17510). This specimen is illustrated herein for the first time (Fig. 5.4, 5.10), together with several cranidia that are regarded here as conspecific (Fig. 5.1–5.3, 5.5–5.9, 5.11–5.15).

These cranidia show well-developed dorsal, marginal, and occipital furrows; a long, unfurrowed, slightly tapered glabella that is well elevated above level of fixigenae; a convex, arched anterior border; a minute, downsloping preglabellar field; very narrow (tr.) and upsloping palpebral areas of fixigenae; and palpebral lobes located at a level slightly behind the center of the glabella. For its part, the pygidium has a large, subparallel-sided pygidial axis composed of three rings and a rounded terminal piece; pleural fields showing faint indications of wide, shallow pleural furrows; a broadly rounded posterior margin; and a pair of posteriorly directed spines, preserving only their bases and proximal parts, extending from the posterolateral corners of the marginal border. The surface of the exoskeleton lacks granulation. Among the numerous species of *Meteoraspis*, the presence of a smooth test, an elongate and tumid glabella, very narrow (tr.) palpebral area of fixigenae, and a proportionately large pygidial axis is diagnostic of *M. metra* (Walcott, 1890) from the *Coosella* Zone of Central Texas and the lower *Crepicephalus* Zone of South Dakota (Walcott, 1890, pl. 21, fig. 7; Lochman, 1938a, pl. 17, figs. 1–8; Palmer, 1954b, p. 753, pl. 82, figs. 2, 4; Stitt and Perfetta, 2000, fig. 9.16–9.19). *Meteoraspis tinguirensis* Rusconi is therefore regarded as a junior synonym of *M. metra*.

Meteoraspis robusta Lochman in Lochman and Duncan, 1944, from the *Cedaria* Zone of Montana, South Dakota, and Texas (Lochman and Duncan, 1944, pl. 9, figs. 11–17; Palmer 1954b, pl. 82, fig. 3; Stitt, 1998, fig. 7.26), differs from *M. metra* by having a shorter (sag.) and less-tumid glabella, wider (tr.) palpebral areas of the fixigenae, and more anteriorly located palpebral lobes.

As stated by Rasetti (1965), *M. brevispinosa* Rasetti, 1965, from the *Crepicephalus* Zone of Tennessee (Rasetti, 1965, pl. 6, figs. 9–12), is differentiated from *M. metra* mainly by having a straighter posterior pygidial margin and extremely short marginal spines. *Meteoraspis spinosa* Lochman in Lochman and Duncan, 1944, from the *Cedaria* Fauna of Montana (Lochman and Duncan, 1944, pl. 9, figs. 18–24), is easily distinguished by bearing noticeable axial spines on the pygidium.

Some species of *Meteoraspis* are only partially known by their cranidia or their pygidia. The cranidia of both *M. elongata* Lochman in Lochman and Duncan, 1944, from the *Cedaria* Fauna of Montana (Lochman and Duncan, 1944, pl. 9, figs. 4–7), and *M. banffensis* Resser, 1942, from the Sullivan Formation of Alberta (Resser, 1942, pl. 13, figs. 5–8), differ from that of *M. metra* mainly by showing a longer (sag.) preglabellar field. For its part, the pygidium of *M. loisi* Lochman in Lochman and Duncan, 1944, from Texas and Montana (Lochman and Duncan, 1944, pl. 5, figs. 24–26; Palmer, 1954b, pl. 82, fig. 1), has a longer postaxial area and a granulate rather than smooth exoskeleton (cf. Stitt and Perfetta, 2000, p. 212). Other granulate species of *Meteoraspis* include *M. keeganensis* Lochman in Lochman and Duncan, 1944 from Montana (Lochman and Duncan, 1944, pl. 9, figs. 1–3, 29), *M. borealis* Lochman, 1938b from Montana and Newfoundland (Lochman, 1938b, pl. 56, figs. 1–5; Lochman and Duncan, 1944, pl. 9, fig. 10; Rasetti, 1946, pl. 70, figs. 3, 4), and *M. delia* Lochman, 1940 from Missouri (Lochman, 1940, pl. 3, figs. 14–20).

Family Crepicephalidae Kobayashi, 1935

Remarks.—Palmer (1954b, 1962) and Pratt (1992) discussed the diagnosis and scope of the family Crepicephalidae Kobayashi, 1935 (=Coosellidae Palmer, 1954b), pointing out the similarities shared by the genera *Crepicephalus* Owen, 1852, *Coosia* Walcott, 1911, *Coosella* Lochman, 1936, *Coosina* Rasetti, 1956, and *Syspacheilus* Resser, 1938.

Genus *Coosia* Walcott, 1911

Type species.—*Coosia superba* Walcott, 1911 from the upper Guzhangian of Alabama and Tennessee, by original designation.

Coosia conicephala (Rusconi, 1954) new combination
Figure 5.16, 5.20, 5.21

1954 *Querandinia conicephala* Rusconi, p. 55, text-fig. 29.

Holotype.—Small cranidium (MCNAM 17448) from La Cruz Olistoliths, 200 m northwest of Estancia San Isidro, Mendoza (Rusconi, 1954, text-fig. 29; Fig. 5.21).

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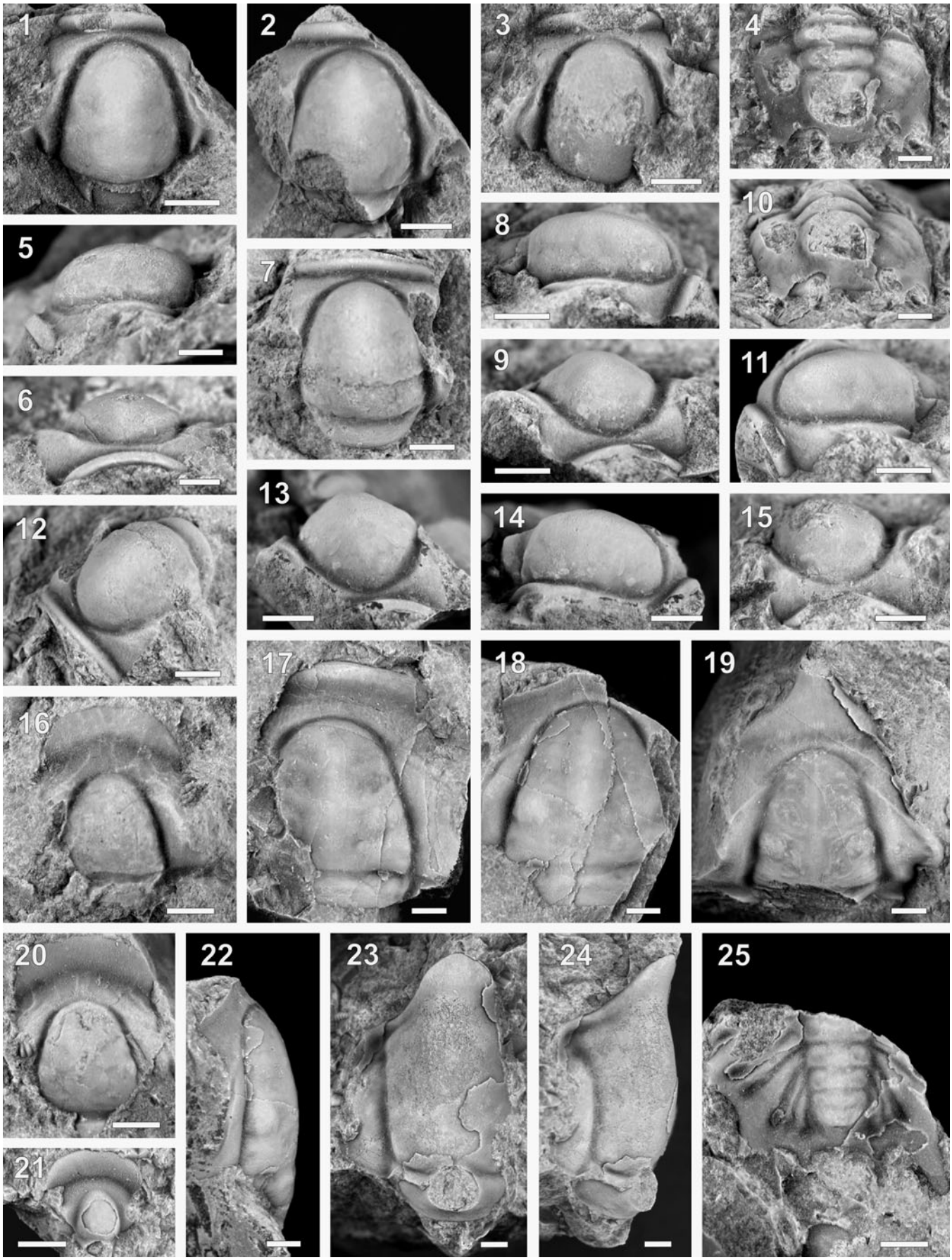

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Figure 5. (**1–15**) *Meteoraspis metra* (Walcott, 1890): (**1, 8, 9, 11**) mostly testate cranidium in dorsal (**1**), oblique (**8, 11**), and anterior (**9**) views, MCNAM 17463; (**2, 13, 14**) testate cranidium in dorsal (**2**), anterior (**13**), and oblique (**14**) views, MCNAM 17618; (**3, 15**) testate cranidium in dorsal (**3**) and anterior (**15**) views, MCNAM 17339; (**4, 10**) partially exfoliated pygidium in dorsal (**4**) and posterior (**10**) views, MCNAM 17510, *Meteoraspis tinguirensis* Rusconi, 1954 holotype (not illustrated previously); (**5, 6**) testate cranidium in lateral (**5**) and anterior (**6**) views, MCNAM 17335; (**7, 12**) partially testate cranidium in dorsal (**7**) and oblique (**12**) views, MCNAM 17609. (**16, 20, 21**) *Coosia conicephala* (Rusconi, 1954): (**16**) exfoliated cranidium, MCNAM 17525; (**20**) testate cranidium, MCNAM 17612; (**21**) small, mostly testate cranidium, MCNAM 17448, *Querandinia conicephala* Rusconi, 1954 holotype (illustrated previously with a sketch, Rusconi, 1954, text-fig. 29). (**17, 18, 22**) *Coosella texana*? Resser, 1942: (**17**) partially exfoliated cranidium, MCNAM 18782; (**18, 22**) partially exfoliated cranidium in dorsal (**18**) and lateral (**22**) views, MCNAM 18037. (**19**) *Nasocephalus* cf. *N. nasutus* Wilson, 1954, mostly exfoliated cranidium, MCNAM 17675. (**23–25**) *Olenoides proa* (Rusconi, 1954): (**23, 24**) partially exfoliated cranidium in dorsal (**23**) and lateral (**24**) views, MCNAM 17445, *Cancapolia proa* Rusconi, 1954 holotype (illustrated previously with a sketch, Rusconi, 1954, text-fig. 28); (**25**) partially exfoliated pygidium, MCNAM 17765. *Cedaria prolifica* Zone of San Isidro, Mendoza. (**1–20, 22–25**) Scale bars = 2 mm; (**21**) scale bar = 1 mm.

Occurrence.—Two hundred meters northwest of Estancia San Isidro, San Isidro area, Mendoza, upper Guzhangian, La Cruz Olistoliths, *Cedaria prolifica* Zone.

Remarks.—Rusconi (1954) erected *Querandinia* Rusconi, 1954 and *Q. conicephala* Rusconi, 1954 on the basis of only a tiny cranidium (holotype) that was originally illustrated with a line drawing (Rusconi, 1954, text-fig. 29). After its original description, the affinities of this specimen remained doubtful (Lochman in Harrington et al., 1959, p. 525; Jell and Adrain, 2003). It shows a broad (sag., exsag.) and flat anterior border, a shallow anterior border furrow, a tapering, anteriorly rounded glabella, effaced glabellar lateral furrows, an almost straight occipital furrow, indications of backwardly oblique eye ridges, and moderately sized palpebral lobes located opposite the middle third of the glabella. Following the diagnosis of Palmer (1954b, p. 730), this specimen is reinterpreted here as an early holaspid of *Coosia* Walcott, 1911, and *Querandinia* is suppressed as a junior synonym of that genus. Two additional, larger cranidia from the Rusconi collection (Fig. 5.16, 5.20) slightly differ from the holotype by showing more clearly curved anterior border furrows.

The variable species *Coosia alethes* (Walcott, 1911), from the *Crepicephalus* Zone of Montana, South Dakota, and Tennessee, includes some cranidia (e.g., Rasetti, 1965, pl. 7, fig. 9; Lochman and Duncan, 1944, pl. 6, fig. 2; Stitt and Perfetta, 2000, fig. 7.21) that have a certain similarity to *C. conicephala*, although the marginal border of the former, like that of many other species of *Coosia*, is less strongly curved forward. In this regard, "*Coosella*" sp. from the *Cedarina dakotaensis* Zone of South Dakota (Stitt, 1998, fig. 8.1) resembles, at first glance, the material from San Isidro but differs in having more anteriorly located palpebral lobes.

Genus *Coosella* Lochman, 1936

Type species.—*Coosella prolifica* Lochman, 1936, from the upper Guzhangian of Missouri, by original designation.

Coosella texana? Resser, 1942
Figure 5.17, 5.18, 5.22

Occurrence.—Two hundred meters northwest of Estancia San Isidro, San Isidro area, Mendoza, upper Guzhangian, La Cruz Olistoliths, *Cedaria prolifica* Zone.

Remarks.—Some crepicephalid cranidia from the Rusconi collection exhibit a poorly convex, elongate, tapered, subconical glabella that is slightly constricted opposite palpebral lobes and rounded anteriorly, occupying more than three-quarters of the total cranidial length; faint indications of three pairs of lateral furrows; a distinct, flat occipital ring representing ~17% of the total glabellar length, lacking node or spine; an equally divided frontal area; a long (sag.), shallow anterior border furrow defining a slightly raised anterior border; a proportionately short (sag.) preglabellar field; and oblique, moderately developed palpebral lobes located slightly anterior to glabellar midlength. These features are characteristic of *Coosella texana* Resser, 1942 as revised by Pratt (1992, p. 65), from the Riley Formation of Texas (Resser, 1942, pl. 13, figs. 21–24, pl. 14, figs. 2–5), the Warrior Formation of Pennsylvania (Tasch, 1951, pl. 46, figs. 13, 14), and the Rabbitkettle Formation of northwest Canada (Pratt, 1992, pl. 22, figs. 17–20). As in the type cranidia from Texas (Resser, 1942, pl. 13, fig. 23, 24, pl. 14, figs. 2, 3), the Argentinian material shows faint glabellar muscle scars that partly mask the lateral furrows and faint traces of radiating prosopon ridges on the preglabellar field. Still, there are no pygidia associated with this material, and it is cautiously classified in open nomenclature.

As stated by Pratt (1992), *C. texana* differs from other species of *Coosella* mainly by having an elongate glabella.

Family Marjumiidae Kobayashi, 1935
Genus *Nasocephalus* Wilson, 1954

Type species.—*Nasocephalus nasutus* Wilson, 1954 from Cambrian clasts in Woods Hollow Shale (Middle Ordovician), Texas, by original designation.

Remarks.—This genus is known from Cambrian boulders of the Woods Hollow Shale of Texas as well as from the *Cedaria selwyni* Zone of the Rabbitkettle Formation of the southern Mackenzie Mountains (Wilson, 1954; Pratt, 1992). One of its most characteristic features is an anterior cranidial border that is extended into a pointed snout having concave sides. Although such a feature is also present in *Dokimocephalus* Walcott, 1924 from the lower Jiangshanian *Elvinia* Zone and correlatives of Nevada, Utah, Oklahoma, Texas, Missouri, Wyoming, and Pennsylvania (Walcott, 1924, 1925; Frederickson, 1948; Palmer, 1960, 1965; Westrop et al., 2010), *Nasocephalus* is easily differentiated by its poorly convex glabella, weaker lateral glabellar furrow S1, and molds lacking granular sculpture.

Nasocephalus cf. *N. nasutus* Wilson, 1954
Figure 5.19

Occurrence.—Two hundred meters northwest of Estancia San Isidro, San Isidro area, Mendoza, La Cruz Olistoliths, *Cedaria prolifica* Zone.

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Description.—A mostly exfoliated cranidium from the Rusconi collection exhibits a low, broadly tapering and anteriorly rounded glabella; dorsal furrows well defined, shallowing anteriorly; lateral glabellar furrows S1, S2, and S3 faint, slightly curved backward, disconnected at middle; preglabellar field short (sag.); anterior border furrow shallow and gently curved forward; anterior border extended into a partially preserved frontal spine; fixigenae moderately narrow (tr.), rising above the glabella; ocular ridges faint, narrow, oblique backward; palpebral lobes arcuate, inflated, elevated above ocular ridges, extended from the level of midpoint of L1 to the level of glabellar furrow S2. The dorsal surface is smooth, while a fragment of test retained on the anterior cranidial border is finely granulated.

Remarks.—This morphology coincides to a large extent with that of *Nasocephalus nasutus* Wilson, 1954, which has been originally described from only two cranidia and one librigena from an upper Guzhangian clast in Woods Hollow Shale (Middle Ordovician) of Texas (Wilson, 1954, pl. 24, figs. 14, 18, 19, 21; Pratt, 1992, p. 89). The Argentinian cranidium differs only slightly by having strongly arcuate rather than semicircular palpebral lobes.

Nasocephalus cf. *N. nasutus* is distinguished from *N. flabellatus* Wilson, 1954, from the Marathon Uplift of Texas (Wilson, 1954, pl. 24, figs. 3, 22) and the *Cedaria selwyni* Zone of the Rabbitkettle Formation, northwestern Canada (Pratt, 1992, pl. 18, figs. 11–20, text-fig. 34), mainly because the latter shows a more subrectangular glabella and longer (exsag.), slightly curved palpebral lobes.

Order Corynexochida Kobayashi, 1935
Family Dorypygidae Kobayashi, 1935
Genus *Olenoides* Meek, 1877

Type species.—*Paradoxides*? *nevadensis* Meek, 1870 from the Miaolingian of Utah, by original designation.

Remarks.—Palmer (1954a), Robison (1964b), and Sundberg (1994) discussed in detail the diagnosis of *Olenoides*, a well-known dorypygid genus that is widespread in the middle Cambrian of North America.

Olenoides proa (Rusconi, 1954) new combination
Figure 5.23–5.25

1954 *Cancapolia proa* Rusconi, p. 54, text-fig. 28.

Holotype.—Cranidium (MCNAM 17445) from La Cruz Olistoliths, 200 m northwest of Estancia San Isidro, Mendoza (Rusconi, 1954, text-fig. 28; Fig. 5.23, 5.24).

Diagnosis.—A species of *Olenoides* with a protruding anterior cranidial margin, a broad-based occipital spine, three pairs of distinctly marked pygidial pleural and interpleural furrows that are straight to slightly curved and become deeper and wider distally, and marginal spines of different sizes.

Occurrence.—Two hundred meters northwest of Estancia San Isidro, San Isidro area, Mendoza, upper Guzhangian, La Cruz Olistoliths, *Cedaria prolifica* Zone.

Description.—Cranidium showing a protruding anterior margin, a long, subrectangular, slightly expanding glabella reaching anterior border, effaced glabellar lateral furrows, and indications of a broad-based occipital spine. Glabella anteriorly fused with a large, concave, tongue-shaped frontal area of cranidium. Fixigenae moderately wide (tr.) and downsloping. Palpebral lobes medium in size and located opposite middle third of glabella.

Pygidium with a long (sag.) and slightly tapered axis, which displays four preserved rings and a broadly rounded terminal piece; axial rings lacking axial nodes; three pairs of distinctly marked pleural and interpleural furrows that are straight to slightly curved and become deeper and wider distally; a weakly defined pygidial border; and a partly preserved margin with at least three pairs of marginal spines having bases of different widths. Pleural fields have anterior pleural bands that expand (exsag.) laterally and posterior pleural bands that are uniform in width.

Remarks.—Rusconi (1954) erected *Cancapolia* Rusconi, 1954 and *C. proa* Rusconi, 1954 on the basis of only a dorypygid cranidium (holotype) that was originally illustrated with a sketch (Rusconi, 1954, text-fig. 28). This specimen is redescribed in the preceding (emended from Rusconi, 1954, p. 55) (Fig. 5.23, 5.24), together with a pygidium (Fig. 5.25) that is regarded here as conspecific. The general aspect of the cranidium as well as the pattern of pygidial pleural furrows and pleural bands (see Sundberg, 1994) are compatible with the middle Cambrian genus *Olenoides* Meek, 1877, so *Cancapolia* is suppressed as a junior synonym of it.

Olenoides is well represented in the Wuliuan, whereas it is rarer in upper Guzhangian strata. Two fragmentary pygidia of *Olenoides* sp. undet., from the *Cedaria*/*Crepicephalus* Zone of Tennessee (Rasetti, 1965, pl. 5, figs. 12, 13), differ from the material from San Isidro mainly by having more curved pleural and interpleural furrows. *Olenoides*? *trispinus* Rasetti, 1946 was based on two pygidia from upper Guzhangian conglomerate boulders from the Gaspé Peninsula in Quebec (Rasetti, 1946, pl. 70, fig. 16) that are distinguished from *O. proa* by their much shallower pleural furrows.

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Declaration of competing interests

The author declares no competing interests.

References

Astini, R.A., Benedetto, J.L., and Vaccari, N.E., 1995, The early Paleozoic evolution of the Argentine Precordillera as a Laurentian rifted, drifted and collided terrane: a geodynamic model: Geological Society of America Bulletin, v. 107, p. 253–273.

Benedetto, J.L., Vaccari, N.E., Waisfeld, B.G., Sánchez, T.M., and Foglia, R.D., 2009, Cambrian and Ordovician biogeography of the South American margin of Gondwana and accreted terranes, *in* Basset, M.G., ed., Early Palaeozoic Peri-Gondwana Terranes: New Insights from Tectonics and Biogeography: Geological Society of London Special Publications, v. 325, p. 201–232.

Bordonaro, O.L., 2003, Review of the Cambrian stratigraphy of the Argentine Precordillera: Geologica Acta, v. 1, p. 11–21.

Bordonaro, O.L., 2014, Nuevos datos sobre *Athabaskia anax* (Walcott, 1916) (Trilobita, Corynexochida) del Cámbrico Medio de la Precordillera de Mendoza, Argentina: Boletín Geológico y Minero, v. 125, p. 561–571.

Bordonaro, O.L., and Banchig, A.L., 1996, Estratigrafía de los olistolitos cámbricos de la Precordillera argentina: 13° Congreso Geológico Argentino y 3° Congreso de Exploración de Hidrocarburos, Buenos Aires, Actas 5, p. 471–479.

Bordonaro, O.L., and Fojo, C.F., 2011, *Bathyuriscus mendozanus* (Rusconi 1945), trilobites del Cámbrico medio de la Precordillera Argentina: Revista Española de Paleontología, v. 26, p. 11–23.

Bordonaro, O.L., and Liñán, E., 1994, Some middle Cambrian agnostoids from the Precordillera Argentina: Revista Española de Paleontología, v. 9, p. 105–114.

Bordonaro, O.L., Beresi, M., and Keller, M., 1993, Reinterpretación estratigráfica del Cámbrico del área de San Isidro, Precordillera de Mendoza: 12° Congreso Geológico Argentino y 2° Congreso de Exploración de Hidrocarburos, Mendoza, Actas 2, p. 12–19.

Borrello, A.V., 1965, Sobre el desarrollo bioestratigráfico del Cámbrico de la Precordillera: Acta Geológica Lilloana, v. 7, p. 39–46.

Borrello, A.V., 1971, The Cambrian of South America, *in* Holland, C., ed., Cambrian of the New World: London, Wiley Interscience, p. 385–438.

Castellaro, H.A., 1963, Faunas cámbricas, *in* Amos, A.J., Camacho, H.H., Castellaro, H.A., and Menéndez, C.A., eds., Guía Paleontológica Argentina: Buenos Aires, Publicación del Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina), p. 13–37.

Cerdeño, E., 2005, La colección de Paleontología del Museo de Ciencias Naturales y Antropológicas "J. C. Moyano" (Mendoza) y sus ejemplares tipo: Contribuciones del MACN, v. 2, 61 p.

Ergaliev, G.K., 1980, [Trilobites of the Middle and Upper Cambrian of Maly Karatau]: Alma-Ata, Akademiya Nauk Kazakhskoi SSR, 211 p. [in Russian]

Frederickson, E.A., 1948, Upper Cambrian trilobites from Oklahoma: Journal of Paleontology, v. 22, p. 798–803.

Fritz, W.H., 1970, *Cambrian faunas, in* Douglas, R.J.W., ed., Geology and economic minerals of Canada: Geological Survey of Canada Economic Geology Report, v. 1, p. 593–600.

Furque, G., and Cuerda, A.J., 1979, Precordillera de La Rioja, San Juan y Mendoza: 2° Simposio de Geología Regional Argentina, Córdoba, v. 1, p. 455–522.

Hall, J., 1863, Supplementary note on some fossils of the lower beds of the Potsdam Sandstone of the Upper Mississippi Valley: New York State Cabinet Natural History 16th Annual Report, p. 221–222.

Harrington, H.J., Henningsmoen, G., Howell, B.F., Jaanusson, V., Lochman, C. et al. 1959, Systematic descriptions, *in* Moore, R.C., ed., Treatise on Invertebrate Paleontology, Part O, Arthropoda 1: Lawrence, Kansas, Geological Society of America and University of Kansas Press, p. 170–540.

Heredia, S., 1995, Conodontes cámbricos y ordovícicos en los bloques alóctonos del conglomerado basal de la Formación Empozada, Ordovícico Medio-Superior, San Isidro, Precordillera de Mendoza, Argentina: Boletín de la Academia Nacional de Ciencias, Córdoba, v. 60, p. 235–247.

Heredia, S., and Beresi, M.S., 2004, La Formación Empozada y su relación estratigráfica con la Formación Estancia San Isidro (nom. nov.), Ordovícico de la Precordillera de Mendoza: Revista de la Asociación Geológica Argentina, v. 59, p. 178–192.

Jell, P.A., and Adrain, J.M., 2003, Available generic names for trilobites: Memoirs of the Queensland Museum, v. 48, p. 331–553.

Keller, M., 1999, Argentine Precordillera. Sedimentary and plate tectonic history of a Laurentian crustal fragment in South America: The Geological Society of America Special Paper, v. 341, 131 p.

Kindle, C.H., 1982, The C.H. Kindle Collection: middle Cambrian to Lower Ordovician trilobites from the Cow Head Group, western Newfoundland: Geological Survey of Canada Paper 82-IC, 17 p.

Kobayashi, T., 1935, The Cambro-Ordovician formations and faunas of South Chosen. Palaeontology. Part 3. Cambrian faunas of South Chosen with a special study on the Cambrian trilobite genera and families: Journal of the Faculty of Science, Imperial University of Tokyo, Section 2, v. 4, p. 49–344.

Lochman, C., 1936, New trilobite genera from the Bonneterre Dolomite (upper Cambrian) of Missouri: Journal of Paleontology, v. 10, p. 35–43.

Lochman, C., 1938a, Upper Cambrian faunas of the Cap Mountain Formation of Texas: Journal of Paleontology, v. 12, p. 72–85.

Lochman, C., 1938b, Middle and upper Cambrian faunas from western Newfoundland: Journal of Paleontology, v. 12, p. 461–477.

Lochman, C., 1940, Fauna of the basal Bonneterre Dolomite (upper Cambrian) of southeastern Missouri: Journal of Paleontology, v. 14, p. 1–53.

Lochman, C., and Duncan, D., 1944, Early upper Cambrian faunas of Central Montana: Geological Society of America Special Papers, v. 54, 181 p.

Lochman, C., and Hu, C.H., 1960, Upper Cambrian faunas from the northwest Wind River Mountains, Wyoming, part I: Journal of Paleontology, v. 34, p. 793–834.

Lochman, C., and Hu, C.H., 1962, Upper Cambrian faunas from the northwest Wind River Mountains, Wyoming, part III: Journal of Paleontology, v. 36, p. 71–29.

Lochman-Balk, C., and Wilson, J.L., 1958, Cambrian biostratigraphy in North America: Journal of Paleontology, v. 32, p. 312–350.

Martin, E.L., Collins, W.J., and Spencer, C.J., 2020, Laurentian origin of the Cuyania suspect terrane, western Argentina, confirmed by Hf isotopes in zircon: Geological Society of America Bulletin, v. 132, p. 273–290.

Meek, F.B., 1870, Descriptions of fossils collected by the U.S. Geological Survey under the charge of Clerence King, Esq.: Proceedings of the Academy of Natural Sciences of Philadelphia, ser. 2, v. 14, p. 56–64.

Meek, F.B., 1877, Paleontology: United States Geological Exploration of the Fortieth Parallel, v. 4, 197 p.

Öpik, A.A., 1967, The Mindyallan fauna of north-western Queensland: Bulletin of the Bureau of Mineral Resources, Geology and Geophysics No. 74, v. 1, 404 p., v. 2, 167 p.

Ortega, G., Albanesi, G.L., Heredia, S.E., and Beresi, M.S., 2007, Nuevos registros de graptolitos y conodontes ordovícicos de las formaciones Estancia San Isidro y Empozada, quebrada San Isidro, Precordillera de Mendoza, Argentina: Ameghiniana, v. 44, p. 697–718.

Owen, D.D., 1852, Report of a geological survey of Wisconsin, Iowa, and Minnesota, and incidentally a portion of Nebraska Territory: Philadelphia, Lippincott, Grambo & Co., 638 p.

Palmer, A.R., 1954a, An appraisal of the Great Basin middle Cambrian trilobites described before 1900: Geological Survey Professional Paper 264-D, p. 55–86, pls. 13–17.

Palmer, A.R., 1954b, The faunas of the Riley Formation in central Texas: Journal of Paleontology, v. 28, p. 709–776, pls. 76–92.

Palmer, A.R., 1960, Trilobites of the upper Cambrian Dunderberg Shale Eureka District, Nevada: United States Geological Survey Professional Paper 334-C, p. 53–109.

Palmer, A.R., 1962, *Glyptagnostus* and associated trilobites in the United States: Geological Survey Professional Paper 374-F, 49 p.

Palmer, A.R., 1965, Trilobites of the late Cambrian Pterocephaliid Biomere in the Great Basin, United States: United States Geological Survey Professional Paper 493, 105 p.

Peng, S., and Robison, R.A., 2000, Agnostid biostratigraphy across the middle–upper Cambrian boundary in Hunan, China: Journal of Paleontology, v. 74 (supplement), 104 p.

Poulsen, C., 1960, Fossils from the late middle Cambrian *Bolaspidella* Zone of Mendoza, Argentina: Matematisk-fysiske Meddelelser, Det Kongelige Danske Videnskabernes Selskab, v. 32, no. 11, 42 p.

Pratt, B.R., 1992, Trilobites of the Marjuman and Steptoean stages (upper Cambrian), Rabbitkettle Formation, southern Mackenzie Mountains, northwest Canada: Palaeontographica Canadiana, v. 19, 179 p.

Pratt, B.R., and Bordonaro, O.L., 2014, Early middle Cambrian trilobites from La Laja Formation, Cerro El Molle, Precordillera of western Argentina: Journal of Paleontology, v. 88, p. 906–924.

Ramos, V.A., Jordan, T.E., Allmendinger, R.W., Mpodozis, C., Kay, S., Cortés, J.M., and Palma, M.A., 1986, Paleozoic terranes of the Central Argentine–Chilean Andes: Tectonics, v. 5, p. 855–880.

Rasetti, F., 1946, Early upper Cambrian trilobites from western Gaspé: Journal of Paleontology, v. 20, p. 442–462.

Rasetti, F., 1956, Revision of the trilobite genus *Maryvillia* Walcott: Journal of Paleontology, v. 30, p. 1266–1269.

Rasetti, F., 1965, Upper Cambrian trilobite faunas of northeastern Tennessee: Smithsonian Miscellaneous Collections, v. 148, no. 3, 127 p., 21 pls.

https://doi.org/10.1017/jpa.2023.34 Published online by Cambridge University Press

Raymond, P.E., 1937, Upper Cambrian and Lower Ordovician Trilobita and Ostracoda from Vermont: Geological Society of America Bulletin, v. 48, p. 1079–1146.
Resser, C.E., 1935, Nomenclature of some Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 93, no. 5, 46 p.
Resser, C.E., 1938, Cambrian System (restricted) of the southern Appalachians: Geological Society of America Special Papers, v. 15, 140 p.
Resser, C.E., 1942, New upper Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 103, no. 5, 136 p.
Robison, R.A., 1964a, Middle–upper Cambrian boundary in North America: Geological Society of America Bulletin, v. 75, p. 987–994.
Robison, R.A., 1964b, Late middle Cambrian faunas from western Utah: Journal of Paleontology, v. 38, p. 510–566.
Robison, R.A., 1988, Trilobites of the Holm Dal Formation (late middle Cambrian), central North Greenland: Meddelelser om Grønland, Geoscience, v. 20, p. 23–103.
Romanenko, E.V., and Romanenko, M.F., 1967, [Some aspects of the Cambrian paleogeography and trilobites of Gorny Altay]: Regional Geographical Society of the USSR, v. 1967, no. 8, p. 62–96. [in Russian]
Rosova, A.V., 1964, [Biostratigraphy and description of trilobites of the middle and upper Cambrian of the northwestern Siberian platform]: Trudy Instituta Geologii i Geofiziki, Akademiya Nauk SSSR, Sibirskoe Otdelenie, 148 p. [in Russian]
Rusconi, C., 1954, Trilobitas cámbricos de la Quebradita Oblicua, sud del cerro Áspero: Revista del Museo de Historia Natural de Mendoza, v. 7, p. 3–59.
Rusconi, C., 1956a, Lista de los géneros y especies fundadas por Carlos Rusconi: Revista del Museo de Historia Natural de Mendoza, v. 9, p. 121–156.
Rusconi, C., 1956b, Mares y organismos extinguidos de Mendoza: Revista del Museo de Historia Natural de Mendoza, v. 9, p. 3–88.
Rusconi, C., 1957, Síntesis de los viajes realizados desde 1952 a 1956: Revista del Museo de Historia Natural de Mendoza, v. 10, p. 87–94.
Rusconi, C., 1962, Correlación de organismos cambro-ordovícicos de varias localidades de Mendoza: Revista del Museo de Historia Natural de Mendoza, v. 14, p. 85–96.
Rusconi, C., 1967, Animales extinguidos de Mendoza y de la Argentina: Mendoza, Edición Oficial del Gobierno de Mendoza, 489 p., 46 pls.
Salter, J.W., 1864, A monograph of the British trilobites from the Cambrian, Silurian and Devonian formations: Monograph of the Palaeontographical Society, 80 p.
Shergold, J.H., Laurie, J.R., and Sun, X., 1990, Classification and review of the trilobite order Agnostida Salter, 1864: an Australian perspective: Bureau of Mineral Resources, Geology and Geophysics Report 296, 93 p.
Shumard, B.F., 1861, The primordial zone of Texas with descriptions of new fossils: American Scientist, ser. 2, v. 32, p. 213–221.
Stitt, J.H., 1998, Trilobites from the *Cedarina dakotaensis* Zone, lowermost part of the Deadwood Formation (Marjuman Stage, upper Cambrian), Black Hills, South Dakota: Journal of Paleontology, v. 72, p. 1030–1046.
Stitt, J.H., and Perfetta, P.J., 2000, Trilobites, biostratigraphy, and lithostratigraphy of the *Crepicephalus* and *Aphelaspis* zones, lower Deadwood Formation (Marjuman and Steptoean stages, upper Cambrian), Black Hills, South Dakota: Journal of Paleontology, v. 74, p. 199–223.
Sundberg, F.A., 1994, Corynexochida and Ptychopariida (Trilobita, Arthropoda) of the *Ehmaniella* Biozone (middle Cambrian), Utah and Nevada: Contributions in Science, v. 446, 137 p.
Sundberg, F.A., 2018, Trilobite biostratigraphy of the Cambrian 5 and Drumian stages, Series 3 (Laurentian Delamaran, Topazan, and Marjuman stages, Lincolnian Series) of the lower Emigrant Formation at Clayton Ridge, Esmeralda County, Nevada: Journal of Paleontology, v. 92, suppl. 76, p. 1–44.
Sundberg, F.A., and Cuen-Romero, F.J., 2021, Trilobites from the *Crepicephalus* Zone (upper Guzhangian Stage, Miaolingian Series, Cambrian) from northern Sonora, Mexico, and its correlation to Arizona and Texas, USA: Journal of South American Earth Sciences, v. 108, n. 103185, https://doi.org/10.1016/j.jsames.2021.103185.
Swinnerton, H.H., 1915, Suggestions for a revised classification of trilobites: Geological Magazine (new series), v. 6, p. 487–496, 538–545.
Tasch, P., 1951, Fauna and paleoecology of the upper Cambrian Warrior Formation of Central Pennsylvania: Journal of Paleontology, v. 25, p. 275–306.
Tortello, M.F., 2011, Late middle Cambrian trilobites from El Totoral, Mendoza, Argentina: Memoirs of the Association of Australasian Palaeontologists, v. 42, p. 115–136.
Tortello, M.F., 2018, Redescription of a *Lotagnostus-Mendoparabolina* faunule (Trilobita; late Furongian) from Quebrada San Isidro, Precordillera of Mendoza, Argentina: Paläontologische Zeitschrift, v. 92, p. 373–386.
Tortello, M.F., 2020, Elviniid trilobites from the *Elvinia* Zone (late Cambrian, Furongian) of Mendoza, western Argentina: Journal of Paleontology, v. 94, p. 852–866.
Tortello, M.F., 2022, Cambrian trilobites from the *Glossopleura walcotti* Zone (Miaolingian Series, Wuliuan Stage) of Mendoza, western Argentina: Journal of Paleontology, v. 96, p. 6113–630.
Tortello, M.F., and Bordonaro, O.L., 1997, Cambrian agnostoid trilobites from Mendoza, Argentina: a systematic revision and biostratigraphic implications: Journal of Paleontology, v. 71, p. 74–86.
Vaccari, N.E., 1996, Trilobites de la Formación La Flecha (Cámbrico Superior), Precordillera argentina. Su importancia bioestratigráfica: Ameghiniana, v. 33, p. 233.
Walcott, C.D., 1884, The paleontology of the Eureka district, Nevada: United States Geological Survey Monograph, v. 8, 298 p.
Walcott, C.D., 1890, Description of new forms of upper Cambrian fossils: Proceedings of the United States National Museum, v. 13, p. 267–279, pls. 20, 21.
Walcott, C.D., 1911, Cambrian faunas of China: Smithsonian Miscellaneous Collections, v. 57, no. 4, p. 69–109, pls. 14–17.
Walcott, C.D., 1916, Cambrian geology and paleontology III, n° 3, Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 64, no. 3, p. 157–258.
Walcott, C.D., 1924, Cambrian geology and paleontology V, n°. 2, Cambrian and lower Ozarkian trilobites: Smithsonian Miscellaneous Collections, v. 75, no. 2, p. 53–60.
Walcott, C.D., 1925, Cambrian geology and paleontology V, n°. 3, Cambrian and Ozarkian trilobites: Smithsonian Miscellaneous Collections, v. 75, no. 3, p. 61–146.
Wallerius, I.D., 1895, Undersökningar öfver zonen med *Agnostus laevigatus* i Vestergötland jämte en inledande öfversikt af Vestergötlands samtliga Paradoxideslager: Lund, Gleerupska Universitets-bokhandeln, 72 p.
Westrop, S.R., and Adrain, J.M., 2013, Biogeographic shifts in a transgressive succession: the Cambrian (Furongian, Jiangshanian; latest Steptoean–earliest Sunwaptan) agnostoid arthropods *Kormagnostella* Romanenko and *Biciragnostus* Ergaliev in North America: Journal of Paleontology, v. 87, p. 804–817.
Westrop, S.R., Ludvigsen, R., and Kindle, C.H., 1996, Marjuman (Cambrian) agnostoid trilobites of the Cow Head Group, western Newfoundland: Journal of Paleontology, v. 70, p. 804–829.
Westrop, S.R., Waskiewicz Poole, R.A., and Adrain, J.M., 2010, Systematics of *Dokimocephalus* and related trilobites from the late Cambrian (Steptoean; Millardan and Furongian Series) of Laurentian North America: Journal of Systematic Palaeontology, v. 8, p. 545–606.
Whitfield, R.P., 1876, Report of reconnaissance from Carroll, Montana Territory, on the Upper Missouri, to the Yellow National Park (Ludlow): Washington, Government Printing Office, 160 p.
Whittington, H.B., and Kelly, S.R.A., 1997, Morphological terms applied to Trilobita, *in* Kaesler, R.L., ed., Treatise on Invertebrate Paleontology, Part O, Arthropoda 1, Trilobita, Revised, Volume 1: Boulder, Colorado, and Lawrence, Kansas, Geological Society of America and University of Kansas Press, p. 313–329.
Wilson, J.L., 1954, Late Cambrian and Early Ordovician trilobites from the Marathon Uplift, Texas: Journal of Paleontology, v. 28, p. 249–285.
Wilson, J.L., 1957, Geography of olenid trilobite distribution and its influence on Cambro-Ordovician correlation: American Journal of Science, v. 255, p. 321–340.

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