

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 57, NUMBER 13

CAMBRIAN GEOLOGY AND PALEONTOLOGY

II

No. 13.—DIKELOCEPHALUS AND OTHER GENERA
OF THE DIKELOCEPHALINÆ

(WITH PLATES 60 TO 70)

BY

CHARLES D. WALCOTT



(PUBLICATION 2187)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
APRIL 4, 1914

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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INTRODUCTION

Many years ago I planned an investigation of the genus *Dikelocephalus*, but under the pressure of other studies and administrative duties it was delayed. Dr. L. C. Wooster in 1883, Dr. Cooper Curtice in 1884, and Dr. Charles Schuchert in 1896 all made extensive collections from the Cambrian of Wisconsin and Minnesota, and it is from this material that many of the illustrations in this paper are taken and the association of species determined.

With but slight study in the past I have referred several species represented by fragments to *Dikelocephalus*, and also accepted similar

references of species by authors. Fortunately Dr. W. C. Brögger studied the genus and in 1886 proposed three new genera that served in a measure to bring order out of the confusion before existing.

I have not been able to secure entire specimens of any species of *Dikelocephalus* (as restricted), but entire dorsal shields of the closely related *Saukia lodensis* (pl. 65) and *Saukia crassimarginata* (pl. 66) give some conception of the probable form of the dorsal shield of the genotype, *D. minnesotensis*.

I am indebted to Mr. Edgar E. Teller, of the Milwaukee Museum, for his permission to illustrate specimens of *Saukia lodensis* and to examine other material in his collection.

Mr. W. A. Finkelburg, of Winona, Minnesota, sent me numerous specimens from the St. Lawrence and Franconia formations about Winona and on the Wisconsin side of the Mississippi River.

CLASSIFICATION

The subfamily Dikelocephalinae Beecher¹ was proposed by its author in 1897 to include the genera *Dikelocephalus*, *Asaphelina* and *Crepicephalus*. Just before Dr. Beecher's paper appeared, Dr. Brögger called attention to the resemblance between *Asaphelina miqueli* Bergeron and the Asaphidæ,² and I agree with him that *Asaphelina* should be grouped under the Asaphidæ and not the Dikelocephalinae.

The third genus mentioned by Beecher, *Crepicephalus* Owen, as shown by entire specimens of *C. teranus* Shumard,³ appears to be more nearly related to the Oleninae.

With the elimination of *Asaphelina* and *Crepicephalus* from the Dikelocephalinae there remains of the genera referred to it by Beecher, only *Dikelocephalus*; with this there is now included in this paper the genus *Conocephalina* (Brögger)⁴ with *Conocephalites ornatus* as the genotype. Brögger also included under *Conocephalina*, *Dikelocephalus osceola* Hall, *D. misa* Hall and *D. spiniger* Hall on account of their having narrow free cheeks, elongate palpebral lobes and an elongate, slightly narrowing glabella. Of these species *D. misa* is retained under *Conocephalina* and *D. osceola* and *D. spiniger* are referred in this paper to other genera. *Conocephalina* is represented by several species in the Cambrian fauna of China.⁵ It is provisionally

¹ Natural Classification of the Trilobites, American Journ. Sci., 4th ser., Vol. 3, 1897, p. 192.

² Nyt Mag. for Naturvid., Vol. 36, 1897, p. 185.

³ U. S. Geol. Survey, Monogr. 32, 1899, part 1, pl. 65, fig. 5.

⁴ Geol. Fören. i Stockholm Förhandl., No. 101, Vol. 8, 1886, pt. 3, p. 206.

⁵ Research in China, Vol. 3, Carnegie Institution of Washington, Pub. No. 54, 1913, Paleontology, The Cambrian Faunas of China, p. 138.

placed in the subfamily Dikelocephalinae as it appears to be an intermediate form between *Dikelocephalus* and *Ptychoparia* as is suggested by Brögger. With the discovery of entire specimens of the genotype, *C. ornatus*, it is possible that it may be placed under some other family or subfamily. There is evidently a group of forms that like *Conocephalites* (= *Conocephalina*) *emmrichi* Barrande (Walcott)¹ will need careful consideration when a review is made of the Olenidae.

Three new genera, *Saukia*, *Osceolia* and *Calvinella*, are proposed in this paper and are referred to the Dikelocephalinae.

With our present information, the following genera are included in the subfamily Dikelocephalinae:

- Dikelocephalus* Owen, 1852
- Conocephalina* Brögger, 1886
- Saukia* Walcott, 1914
- Osceolia* Walcott, 1914
- Calvinella* Walcott, 1914

Observations on the genera.—*Dikelocephalus* (restricted) appears to be distinct from all other genera by the broad, flattened border of its cephalon, large eyes placed well back, large, broad subquadrangular glabella with strong posterior furrow, and large, wide pygidium with broad, flattened border.

Saukia has a narrow frontal border about the cephalon and a glabella proportionally more elongate than in *Dikelocephalus*. The pygidium of *Saukia* is less expanded and proportionally more elongate than that of *Dikelocephalus*.

The cranidium of Brögger's genus *Conocephalina* (1886) has a somewhat similar form to that of *Saukia*, but the strong transverse posterior glabellar furrow of *Saukia*, and the absence of a clearly marked frontal limb in advance of the glabella serve to distinguish the cranidium of *Saukia*. The pygidium associated with *Conocephalina ornata* is transverse with a spinose margin, while that of *Saukia* is nearly as long as broad and the margin is unbroken by spines.

Osceolia is characterized by its concave frontal limb, elongate palpebral lobes; narrow fixed cheeks and transverse pygidium with its anterior segment extended beyond the margin as a long, strong spine.

Calvinella is most like *Saukia*, from which it differs in form of glabella, presence of a strong occipital spine and proportionally more

¹ Research in China, Vol. 3. Carnegie Institution of Washington, Pub. No. 54, 1913, Paleontology, The Cambrian Faunas of China, pl. 13, fig. 7.

elongate pygidium. It differs from *Osceolia* in frontal limb of cephalon; presence of occipital spine and character of pygidium.

Further observations on the genera will be found under the description of each genus.

SYNONYMIC REFERENCES

The following is a list of the species that have been referred to *Dikelocephalus*¹ and which are now referred to other genera. It is only approximately complete, as many references that occur in textbooks and in general discussion of the fauna are omitted.

FORMER GENERIC REFERENCE.	PRESENT GENERIC REFERENCE.
<i>Dikelocephalus affinis</i> Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 197)	<i>Platycolpus</i> Raymond. ²
<i>Dikelocephalus angusticauda</i> (Angelin) Linnarsson, Brögger (Die Sil. Etagen 2 und 3, Kristiania, 1882, p. 126)	<i>Apatokephalus</i> Brögger.
<i>Dikelocephalus</i> (?) <i>angustifrons</i> Walcott (Monogr. U. S. Geol. Survey, Vol. 8, 1884, p. 42, pl. 10, figs. 1, 1a, 1b)	<i>Lisania</i> Walcott.
<i>Dikelocephalus barabuensis</i> Whitfield (Ann. Rep. for 1877, Wis. Geol. Survey, 1878, p. 63)	<i>Platycolpus</i> Raymond.
<i>Dikelocephalus</i> ? <i>baubo</i> Walcott (Proc. U. S. Nat. Museum, Vol. 29, 1905, p. 91)	<i>Ptychaspis</i> Hall.
<i>Dikelocephalus</i> ? <i>bavaricus</i> (Barrande) Brögger (Nyt Mag. for Naturvid., Vol. 36, 1898, p. 212)	Genus undt.
<i>Dikelocephalus belli</i> Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 403, text fig. 378)	<i>Anomocarella</i> Walcott.
<i>Dikelocephalus billingsi</i> Linnarsson (Geol. Fören. Stockholm Förhandl., Vol. 2, 1875, p. 492, pl. fig. 1)	<i>Acerocare</i> Angelin.
<i>Dikelocephalus bilobatus</i> Hall and Whitfield (U. S. Geol. Expl. 40th Parl., Vol. 4, 1877, p. 226, pl. 2, fig. 36)	<i>Platycolpus</i> Raymond.
<i>Dikelocephalus</i> ? <i>brizo</i> Walcott (Proc. U. S. Nat. Mus., Vol. 29, 1905, p. 92)	<i>Ptychaspis</i> Hall.
<i>Dicellocephalus bröggeri</i> Moberg (Aftryck ur Kongl. Fysiogr. Sällsk. Handl. Lund, Bd. 17, 1906, p. 87, pl. 5, figs. 7, 8)	Genus undt. cf. <i>Platycolpus</i> Raymond.

¹The original spelling of the genus is adhered to in this paper, but under synonymic references the spelling used by each author has been retained, the alphabetical sequence according to species names being followed.

²Memoirs Victoria Memorial Museum, Geol. Survey Canada, Bull. 1, 1913, p. 63.

FORMER GENERIC REFERENCE.	PRESENT GENERIC REFERENCE.
<i>Dikelocephalus celticus</i> Salter (Mem. Geol. Surv. Great Britain, Vol. 3, 1866, p. 304) . . .	Undt. genus. Species founded on distorted pygidia.
<i>Dikelocephalus cristatus</i> Billings (Canadian Nat. Geol., Vol. 5, 1860, p. 312, text fig. 10) . . .	<i>Conocephalina</i> Brögger ?
<i>Dikelocephalus</i> (?) <i>corax</i> Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 334, text fig. 322a-b)	Genus undt.
<i>Dikelocephalus crassimarginatus</i> Whitfield (Geol. Wisconsin, Vol. 4, 1882, p. 344, pl. 27, fig. 14)	<i>Saukia</i> Walcott.
<i>Dikelocephalus devinci</i> Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 195, fig. 180)	<i>Ptychoparia</i> ? Corda.
<i>Dikelocephalus dicraurus</i> (Angelin) (Linnarsson) Brögger (Die Sil. Etagen 2 und 3, Kristiania, 1882, p. 126)	<i>Dikelocephalina dicraeura</i> .
<i>Dikelocephalus discoidalis</i> Salter (Mem. Geol. Surv. Great Britain, Vol. 3, 1866, p. 304) . . .	Genus undt. Species founded on fragments of distorted cranidia.
<i>Dikelocephalus dubius</i> (Linnarsson) Brögger (Nyt Mag. for Naturvid., Vol. 35, 1897, p. 175, figs. 5a-b)	<i>Apatokephalus dubius</i> .
<i>Dikelocephalus catoni</i> Whitfield (Ann. Rep. Surv. Wisconsin for 1877, 1878, p. 65)	<i>Platycolpus</i> Raymond.
<i>Dikelocephalus</i> (?) <i>expansus</i> Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 45, pl. 9, fig. 19)	<i>Dolichometopus</i> Angelin.
<i>Dikelocephalus finalis</i> Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 89)	<i>Apatokephalus</i> Brögger (1896).
<i>Dikelocephalus flagricaudus</i> White (Geog. and Geol. Expl. and Surv. West 100th Merid., Vol. 4, pt. 1, 1875, p. 60)	<i>Zacanthoides</i> Walcott.
<i>Dikelocephalus flabellifer</i> Hall and Whitfield (U. S. Geol. Expl. 40th Parl., Vol. 4, 1877, p. 227, pl. 2, figs. 29, 30)	<i>Apatokephalus</i> Brögger (1896).
<i>Dikelocephalus florentincnsis</i> Etheridge (Records Australian Museum, Sydney, Vol. 5, 1905, p. 99, pl. 10, fig. 4)	<i>Dikelocephalina</i> Brögger.
<i>Dikelocephalus</i> (<i>Centropleura</i> ?) <i>furca</i> Salter (Mem. Geol. Surv. Great Britain, Vol. 3, 1866, p. 303)	<i>Dikelocephalina</i> Brögger.
<i>Dikelocephalus</i> ? <i>gothicus</i> Hall and Whitfield (U. S. Geol. Expl. 40th Parl., Vol. 4, 1877, p. 242)	<i>Olenoides wasatchensis</i> Hall and Whitfield.
<i>Dikelocephalus granulosus</i> Owen (Rept. Geol. Surv. Wis., Iowa, and Minn., 1852, p. 575) . .	<i>Ptychaspis</i> Hall (1863).

FORMER GENERIC REFERENCE.

PRESENT GENERIC REFERENCE.

- Dikelocephalus hartti* (Walcott) Stose (U. S. Geol. Surv. Geol. Atlas, U. S. Folio No. 170, 1909, p. 6) *Dikelocephalus* Owen.
- Dikelocephalus hisingeri* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 196) *Lisania* Walcott ?
- Dicelloccephalus inexpectans* Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 90, pl. 1, fig. 10) *Conocephalina* Brögger.
- Dicelloccephalus ? interpres* Read (Mem. Geol. Surv. India, ser. 15, Vol. 7, Mem. No. 1, Cambrian Fossils of Spiti, 1910, p. 38, pl. 5, figs. 9-13) *Ptychoparia* Corda ?
- Dicelloccephalus iole* Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 43, pl. 10, fig. 19) *Conocephalina* Brögger ?
- Dikelocephalus iowensis* Owen (Geol. Surv. Wis., Iowa, and Minn., 1852, p. 575) *Crepicephalus* Owen.
- Dikelocephalus latifrons* Shumard (Trans. Acad. Sci., St. Louis, Vol. 2, 1863, p. 101) *Ptychoparia wisconsinensis* (Owen).
- Dicelloccephalus ? leptanarum* Wiman (Arkiv för Zoologi, Bd. 3, 1906, No. 24, p. 5, pl. 12, figs. 1-3) *Saukia* Walcott ?
- Dikelocephalus lodensis* Whitfield (Geol. Wisconsin, Vol. 4, 1882, p. 188, pl. 10, fig. 14, pl. 27, figs. 12, 13) *Saukia* Walcott.
- Dikelocephalus (Centropheura) loveni* (Angelin) Koken (Die Leitfossilien, Leipzig, 1896, p. 17) *Paradoxides loveni* Angelin.
- Dikelocephalus magnificus* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 400) New genus *Hungaia* Walcott (MSS.).
- Dikeloccephalus ? marcoui* Whitfield (Bull. American Mus. Nat. Hist., Vol. 1, 1884, p. 150) *Olenoides* Meek.
- Dikelocephalus marica* Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 44, pl. 10, fig. 13) *Saukia* Walcott
- Dikelocephalus megalops* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 403) *Conocephalina* Brögger.
- Dicelloccephalus microphthalmus* Holm (Geol. Fören. i Stockholm Förhandl., Vol. 19, 1898, p. 466) *Anomocare* Angelin ?
- Dicelloccephalus minnesotensis* ?. Identified by R. P. Whitfield. (Monogr. U. S. Geol. Survey, Vol. 12, 1886, p. 60) *Saukia coloradoensis* Walcott.
- Dikelocephalus minnesotensis limbatus* Hall (Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1863, pl. 141, pl. 9, fig. 12) *Dikelocephalus limbatus* Hall.
- Dikelocephalus miniscaensis* Owen (Geol. Surv. Wis., Iowa, and Minn., 1852, p. 574) *Ptychaspis* Hall.

FORMER GENERIC REFERENCE.

PRESENT GENERIC REFERENCE.

- Dicellosephalus missa* Berkey (Am. Geologist, Vol. 21, 1898, p. 290, pl. 20, figs. 12, 13).....*Anomocare* ? Angelin.
- Dikelocephalus missa* Hall (Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1863, p. 144, pl. 8, fig. 15; pl. 10, figs. 4, 5).....*Conocephalina* Brögger.
- Dikelocephalus missisquoi* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 199).....New genus.
- Dikelocephalus multicinctus* Hall and Whitfield (U. S. Geol. Expl. 40th Parl., Vol. 4, 1877, p. 226, pl. 2, fig. 36).....*Apatokephalus* Brögger (1896).
- Dikelocephalus nasutus* Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 40, pl. 10, fig. 15).....*Proampyx* Frech.
- Dikelocephalus newtonensis* Weller (Geol. Surv. New Jersey, Rep. on Pal., Vol. 3, 1903, pp. 121-122, pl. 3, figs. 1-7).....*Calvinella* Walcott.
- Dikelocephalus osceola* Hall (Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1863, p. 146, pl. 10, fig. 18; pl. 7, fig. 49).....*Oscoclia* Walcott.
- Dikelocephalus oweni* Billings (Canadian Nat. Geol., Vol. 5, 1860, p. 310, text fig. 8).....*Anomocarella* Walcott ?
- Dikelocephalus pauper* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 200)....*Ptychaspis* Hall ?
- Dikelocephalus pepinensis* Owen (Rept. Geol. Surv. Wis., Iowa, and Minn., 1852, p. 574, pl. 1, figs. 9, 9a).....*Saukia* Walcott.
- Dikelocephalus planifrons* Billings (Canadian Nat. Geol., Vol. 5, 1860, p. 309, text fig. 6)..*Anomocarella* Walcott ?
- Dikelocephalus quadriiceps* Hall and Whitfield (U. S. Geol. Surv. 40th Parl., Vol. 4, 1877, p. 240).....*Olenoides* Meek.
- Dikelocephalus richmondensis* Walcott (Monogr. U. S. Geol. Surv., Vol. 8, 1884, p. 41, pl. 10, fig. 7).....*Ptychoparia* Corda.
- Dikelocephalus roemeri* Shumard (American Journ. Sci., 2d ser., Vol. 32, 1861, p. 220)....*Ptychoparia* Corda.
- Dikelocephalus selectus* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 199)....*Ptychaspis* Hall ?
- Dikelocephalus serratus* (Boeck) (Linnars-son) Brögger (Die Sil. Etagen 2 und 3, Kristiania, 1882, p. 126).....*Apatokephalus* Brögger.
- Dikelocephalus sesostris* Billings (Geol. Surv. Canada, Pal. Foss., Vol. 1, 1865, p. 198)....*Ptychaspis* Hall.
- Dicellosephalus* ? *sinensis* Bergeron (Bull. Soc. géol. de France, Vol. 27, 1899, p. 508)..*Stephanocare* Monke.
- Dikelocephalus spiniger* Hall (Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1863, p. 143, pl. 10, figs. 1, 2, 3 ?).....*Calvinella* Walcott.

FORMER GENERIC REFERENCE.

PRESENT GENERIC REFERENCE.

Dikelocephalus tasmanicus Etheridge (Proc. Royal Soc. Tasmania for 1882, 1883, p. 155, pl. 1, fig. 4).....*Dikelocephalina* Brögger.
Dicelloccephalus ? villebruni Bergeron (Bull. Soc. géol. de France, 3d ser., Vol. 23, 1895, p. 473, pl. 5, figs. 1, 2).....*Dikelocephalina* Brögger.
Dikellocephalus wahsatchensis Hall and Whitfield (U. S. Geol. Expl. 40th Parl., Vol. 4, 1877, p. 241).....*Olenoides* Meek.

STRATIGRAPHIC POSITION OF THE DIKELOCEPHALINÆ

It has been evident for several years that the various Cambrian formations of the Upper Mississippi Valley, which had been referred first to the Potsdam and then to the St. Croix sandstones, needed careful revision in relation to their stratigraphic position and succession.

The original classification of Owen (1852) was superseded by the classification of the Minnesota Survey for the Minnesota sections, and for Wisconsin by the classification of the Geological Survey of Wisconsin. The two latter classifications were as follows :

WISCONSIN	MINNESOTA
1. Madison Sandstone.	1. Jordan Sandstone.
2. Mendota Limestone.	2. St. Lawrence Limestone.
3. { Calcareous Sandstone. Shale. Fine quartzose Sandstones. Coarse quartzose Sandstone.	3. { Sand and sandy Shales. Dresbach Sandstone. Shales. Hinckley Sandstone.

During the summer of 1913 Dr. E. O. Ulrich, who had long been studying the Lower Paleozoic formations of the Mississippi Valley south of Wisconsin and Minnesota, extended his investigations into those states and by combining stratigraphic and paleontologic methods succeeded in delimiting six formations, including the upper Jordan sandstone and the basal sandstone of the Minnesota Survey. He found that the Mendota limestone and the Madison sandstone, which had been previously correlated with the Jordan sandstone and the St. Lawrence limestone respectively of the Minnesota Survey, were both above the Jordan sandstone and separated from it by an unconformity; also that their included fossils correlated them with the Ozarkian formations of his Missouri section.¹

¹ Bull. Geol. Soc. America, Vol. 22, 1911, p. 608, pl. 27.

The provisional classification of the pre-Ordovician formations in the Upper Mississippi Valley is as follows:

	Formations.	Lithologic characters.
Canadian	Shakopee 60'	Dolomite.
	Oneota 110'	Dolomite.
Ozarkian	Madison 40'	Magnesian and calcareous sandstone.
	Mendota	Dolomite.
	Jordan (Winchell 1874) 60-80'	Heavy bedded soft, rather coarse-grained, yellowish sandstone.
Upper Cambrian (St. Croixan)	St. Lawrence (Winchell 1874) 120'	Soft fine-grained brown, red, green or ash-colored sandstone often dolomitic near top. Yellow and ash-colored argillaceous-calcareous, thin-bedded rock near middle, and green sands interbedded with yellow sandstones in lower third.
	Franconia (Berkey 1898) 85'	A series of thin and thick-bedded usually soft sandstones with much green material throughout or only in portions. The upper fifty feet often harder than the underlying beds and containing a considerable fauna, especially species of <i>Conaspis</i> . In many localities other fossiliferous beds occur in the central and lower portions.
	Dresbach (Winchell 1888) 100'	Massive-bedded, rather coarse-grained sandstone, with a thin bed of shale at the base and shaly sandstone near the middle. Fossils at the top and base, consisting almost entirely of shells of <i>Dicelomus</i> and <i>Lingulella</i> .
	Eau Claire (Ulrich MSS. 1914) About 100'	Mostly thin-bedded, in part shaly sandstone, with many fossiliferous layers, including Owen's Menomonic and Wooster's Eau Claire trilobite zones. Usually a coarse white friable sandstone with <i>Dicelomus</i> and <i>Lingulella</i> at the base. Numerous characteristic trilobites, <i>Crepicephalus iowensis</i> being one of the best of the guide fossils.
	Mt. Simon (Ulrich MSS. 1914) 235'+	A series of coarse sandstones and grits resting on pre-Cambrian granite. About 225 feet are shown in the bluffs at Eau Claire and 50 feet of the base at Chippewa Falls, Wisconsin. Except <i>Scolithus</i> borings no fossils have been found.

Jordan formation.—In Wisconsin this is a rather coarse-grained, thick-bedded, compact but soft, slightly calcareous, light-colored sandstone.¹ In Minnesota it is described as white and siliceous and locally forming rather firm layers that break up into angular blocks.²

As far as known the Jordan sandstone as limited by Ulrich has not furnished any fossils *in situ*. There is, however, a fauna collected from sandstones in the vicinity of Devil's Lake, Sauk County, Wisconsin, that may belong at this horizon. It includes from locality 81b the following species:

<i>Arenicolites woodi</i> Whitfield	<i>Saukia</i> cf. <i>pyrene</i> Walcott
<i>Finkelburgia finkelburgi</i> (Walcott)	<i>Osceolia</i> cf. <i>osceola</i> (Hall)
<i>Syntrophia barabucensis</i> (A. Winchell)	<i>Agraulos</i> ? sp. undt.
<i>Straparollus</i> ? (<i>Ophileta</i> ?) <i>primordialis</i> Winchell	<i>Ptychaspis</i> sp. undt.
<i>Dikelocephalus</i> cf. <i>limbatus</i> Hall	<i>Platycolpus barabucensis</i> (Whitfield)
<i>Saukia</i> cf. <i>crassimarginata</i> (Whitfield)	<i>Platycolpus</i> cf. <i>catoni</i> (Whitfield)
	<i>Illænurus</i> sp. undt.
	<i>Couaspis</i> cf. <i>anatina</i> (Hall).

The specimens occur in a friable sandstone similar to that of the Jordan formation and unlike the supposedly older, more or less calcareous St. Lawrence formation. The fauna is of the same general facies as that of the upper portion of the St. Lawrence formation, but the trilobites differ in minor details, and there are also present two trilobites closely simulating *Platycolpus barabucensis* and *P. catoni* (Whitfield). The two latter are types suggesting the succeeding Ozarkian period, the typical varieties of the species, being characteristic of the superjacent Mendota dolomite.

St. Lawrence formation.—The eastern Wisconsin phase of this formation is described as consisting of alternating strata of arenaceous magnesian limestone, sandy calcareous shales, and shaly and calcareous sandstones.³

In Minnesota the St. Lawrence limestone is formed of an upper regularly bedded magnesian limestone from 30 to 50 feet in thickness, and "below these massive layers, which constitute a part of the precipitous bluffs of the county, there is a varying thickness of more fragile indescribable rock, which can best be defined by Dr. Owen's term *siliceo-argillaceous dolomite*, with occasional layers of an inch or two of crumbling white sand. There is also a slow transition from the crumbling sandstone of the St. Croix to the dolomitic firm rock of the St. Lawrence. . . . At ten or fifteen feet higher [from the base] the rock has assumed that character which is almost indescrib-

¹ Chamberlin, Geol. Wisconsin, Vol. 2, 1877, p. 260.

² Winchell, N. H., Geol. Minnesota, Vol. 1, 1884, p. 253.

³ Geol. Wisconsin Vol. 2, 1877, p. 261.

able, being greenish and shaly and yet not a shale, calcareous but not a limestone, magnesian but not a dolomite, finely siliceous but not a sandstone. This character continues through a thickness of forty to fifty feet of strata."¹

St. Lawrence fauna.—The fauna of the upper beds at Osceola, Wisconsin (Locality 78), includes a large group of species as follows:

<i>Lingulella mosia</i> (Hall)	<i>Owenella antiquata</i> (Whitfield)
<i>Lingulella mosia osceola</i> (Walcott)	<i>Murchisonia</i> sp. undt.
<i>Lingulella winona</i> (Hall)	<i>Agnostus disparilis</i> Hall
<i>Lingulella winona convexa</i> (Walcott)	<i>Ptychaspis</i> sp. (also at Devils Lake, 81)
<i>Billingsella coloradoensis</i> (Shumard)	<i>Ptychaspis</i> ? sp.
<i>Finkelnburgia finkelnburgi</i> (Walcott)	<i>Dikelocephalus</i> ? <i>limbatus</i> Hall
<i>Finkelnburgia osceola</i> (Walcott)	<i>Dikelocephalus minnesotensis</i> Owen ?
<i>Finkelnburgia osceola corrugata</i> (Walcott)	<i>Saukia leucosia</i> Walcott
<i>Syntrophia barabuensis</i> (A. Winchell)	<i>Saukia pyrene</i> Walcott
<i>Hyalolithes</i> ? <i>corrugatus</i> Walcott	<i>Osceolia osceola</i> (Hall)
<i>Spiroentalium osceola</i> Walcott	<i>Ptychoparia</i> ? <i>bindosa</i> (Hall)
<i>Holopea sweeti</i> Whitfield	<i>Ptychoparia</i> sp.
<i>Metoptoma</i> sp.	<i>Illænurus quadratus</i> Hall
<i>Platyceras</i> ?	<i>Triarthrella auroralis</i> Hall

At an horizon 50 feet (15 m.) above the St. Croix River *Saukia crassimarginatus* (Whitfield) (78b) occurs in association with several of the species in above list. *Calvinella spiniger* Hall is abundant at about this horizon in the calcareo-arenaceous beds of locality 83¹ at Trempealeau, and it also occurs lower down in this section at 83².

In the lower arenaceo-calcareous beds *Dikelocephalus minnesotensis* has its greatest development. This sub-fauna includes:

<i>Obolus (Westonia) aurora</i> (Hall)	<i>Dikelocephalus minnesotensis</i> Owen
<i>Obolus (Westonia) stoneanus</i> (Whitfield)	<i>Saukia crassimarginata</i> (Whitfield)
<i>Lingulella mosia</i> (Hall)	<i>Saukia lodensis</i> (Whitfield)
<i>Lingulella oweni</i> (Walcott)	<i>Saukia pepinensis</i> (Owen)
<i>Lingulella winona</i> (Hall)	<i>Calvinella spiniger</i> (Hall)
<i>Lingulella winona convexa</i> (Walcott)	<i>Ptychoparia binodosa</i> (Hall)
<i>Finkelnburgia osceola</i> (Walcott)	<i>Triarthrella auroralis</i> Hall
<i>Syntrophia primordialis</i> (Whitfield)	<i>Ptychaspis</i> n. sp.
<i>Serpulites murchisoni</i> Hall	<i>Illænurus quadratus</i> Hall
<i>Owenella antiquata</i> (Whitfield)	<i>Illænurus</i> n. sp.
<i>Owenella vaticina</i> (Hall)	<i>Aglaspis eatoni</i> Whitfield
	<i>Aglaspis barrandei</i> Hall

Dendrograptus hallanus Prout is not represented in our collection. Known from Osceola, Wisconsin, and Lake City, Minnesota.

¹ Geol. Minnesota, Vol. 1, 1884, p. 255.

The Franconia formation.—In Wisconsin and Minnesota beneath the strata referred to the St. Lawrence series are found more or less calcareous shales and sandstones. The only trace of the Dikelocephalinæ is in the upper arenaceous shales and thin layers of sandstone of the Franconia horizon. This is found in *Conocephalina misa* (Hall). The associated fauna is quite distinct from that of the St. Lawrence formation, and includes (79a, 79b, 80a, 97, 99a, 100) :

<i>Obolus matinalis</i> (Hall)	<i>Syntrophia primordialis argia</i> Walcott
<i>Obolus mickwitzii</i> Walcott	<i>Palæacmæa irvingi</i> Whitfield
<i>Obolus (Westonia) aurora</i> (Hall)	<i>Eccyliomphalus</i> n. sp.
<i>Lingulella mosia</i> (Hall)	<i>Agnostus josepha</i> Hall
<i>Lingulella mosia osceola</i> (Walcott)	<i>Agnostus parilis</i> Hall
<i>Lingulella oweni</i> (Walcott)	<i>Lonchocephalus hamulus</i> Owen
<i>Lingulella phaon</i> (Walcott)	<i>Lonchocephalus wisconsinensis</i> Owen
<i>Lingulella similis</i> (Walcott)	<i>Ptychaspis granulosa</i> (Owen)
<i>Lingulella winona</i> (Hall)	<i>Ptychaspis miniscaensis</i> (Owen)
<i>Lingulella winona convexa</i> (Walcott)	<i>Ptychaspis striata</i> Whitfield
<i>Lingulella (Lingulepis) acuminata</i> (Conrad)	<i>Chariocephalus whitfieldi</i> Hall
<i>Dicellomus politus</i> (Hall)	<i>Chariocephalus</i> sp.
<i>Eoorthis ? diablo</i> Walcott	<i>Conaspis¹ anatina</i> (Hall)
<i>Eoorthis remnicha</i> (N. H. Winchell)	<i>Conaspis bipunctata</i> (Shumard)
<i>Eoorthis remnicha sulcata</i> (Walcott)	<i>Conaspis eryon</i> (Hall)
<i>Eoorthis remnicha winfieldensis</i> (Walcott)	<i>Conaspis nasuta</i> (Hall)
<i>Eoorthis</i> sp.	<i>Conaspis oweni</i> (Hall) ?
<i>Otusia sandbergi</i> N. H. Winchell	<i>Conaspis patersoni</i> (Hall)
<i>Billingsella coloradoensis</i> (Shumard)	<i>Conaspis perseus</i> (Hall)
<i>Finkelnburgia finkelnburgi</i> (Walcott)	<i>Conaspis ? shumardi</i> (Hall ?)
<i>Finkelnburgia osceola</i> (Walcott)	<i>Ptychoparia diademata</i> (Hall)
<i>Syntrophia primordialis</i> (Whitfield)	<i>Elliptocephalus ? curtus</i> (Whitfield)
	<i>Conocephalina misa</i> (Hall)

¹ CONASPIS Hall.¹

Dr. Th. Lorenz² places two species under the genus *Macrotoxus*: *Anomocare angelini* Grönwall [1902] and *Conocephalites perseus* Hall [1863]. I think *A. angelini* Grönwall is a true *Anomocare* and should be retained in that genus, which makes *Macrotoxus* a synonym of *Conaspis* Hall.

The genotype of *Conaspis* will now be *C. perseus* (Hall). It is representative of a group of species in the Upper Cambrian formations allied to *Ptychoparia* that are characterized by a subconical glabella, medium sized eye-lobes, rather strong postero-lateral limbs, narrow fixed checks, and with facial sutures extending almost directly forward from the eye lobes so as to form a narrow frontal limb; the frontal rim is usually well defined and cut obliquely by the facial sutures.

The species I now refer to *Conaspis* from the St. Croixian of the upper Mississippi Valley are:

¹ Sixteenth Ann. Rept. New York State Cat. Nat. Hist., 1863, p. 152.

² Zeitschr. deutsch. geol. Gesellsch., Bd. 58, 1906, p. 61.

Fauna of Eau Claire formation.—The fauna of the Eau Claire sandstones is marked especially by *Anomocarella woosteri*, *Crepicephalus texanus*, and *Crepicephalus iowensis*.

The fauna includes near Eau Claire, Wisconsin, the following species at the highest horizon on Mount Washington, locality 78a:

<i>Obolus</i> sp. undt.	<i>Pagodiathea</i> (Walcott)
<i>Dicellogomus pectenoides</i> (Whitfield)	<i>Crepicephalus iowensis</i> Owen
<i>Dicellogomus politus</i> (Hall)	

At a slightly lower horizon the following species occur, locality 98x:

Worm borings	<i>Ptychoparia chippewaensis</i> Owen
<i>Obolus matinalis</i> (Hall)	<i>Ptychoparia optata</i> Hall
<i>Lingulella mosia</i> (Hall)	<i>Crepicephalus iowensis</i> Owen
<i>Lingulella phaon</i> (Walcott)	<i>Crepicephalus texanus</i> Shumard
<i>Dicellogomus politus</i> (Hall)	<i>Agraulos</i> sp. undt.
<i>Hyalolithes primordialis</i> Hall	<i>Pagodiathea</i> (Walcott)
<i>Stenotheca</i> sp. undt.	<i>Anomocarella</i> sp. undt.
<i>Agnostus josepha</i> Hall	<i>Anomocarella ouusta</i> (Whitfield)
<i>Ptychoparia</i> ? <i>calymenoides</i> Whitfield	<i>Anomocarella woosteri</i> (Whitfield)

Additional species occur at other localities as follows:

<i>Obolus mickwitzii</i> Walcott	<i>Billingsella coloradoensis</i> (Shumard)
<i>Obolus namouna</i> Walcott	<i>Pemphigaspis bullata</i> Hall
<i>Obolus rhea</i> Walcott	<i>Lonchocephalus</i> ? <i>minor</i> (Shumard)
<i>Obolus</i> (<i>Westonia</i>) <i>aurora</i> (Hall)	<i>Ptychoparia</i> ? <i>quadrata</i> (Whitfield)
<i>Lingulella winona</i> (Hall)	<i>Anomocarella</i> ? <i>winona</i> (Hall)
<i>Lingulella winona convexa</i> (Walcott)	
<i>Lingulella</i> (<i>Lingulepis</i>) <i>acuminata</i> (Conrad)	

Pemphigaspis bullata seems to be confined to the uppermost beds referred to the formation.

Stratigraphic range of the genera.—From the preceding lists it will be seen that with our present information the genera of the Dikelocephalinæ in the central region of the continent range from the sand-

<i>Conocephalites anatinus</i> Hall	<i>Conocephalites perseus</i> Hall
<i>Conocephalites eryon</i> Hall	<i>Ptychoparia patersoni</i> (Hall)
<i>Conocephalites nasutus</i> Hall	<i>Arionellus bipunctatus</i> Shumard ?
<i>Conocephalites oweni</i> Hall	

[All described in Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., 1863.]

That from the Upper Cambrian of Texas is:

Ptychoparia llanoensis Walcott

[Described in Proc. U. S. Nat. Mus., Vol. 13, 1890, pp. 272-274.]

stones of the Franconia formation upward through the St. Lawrence formation into the base of the Jordan sandstone of Wisconsin and Minnesota.

In Missouri *Calvinella ozarkensis* (pl. 70, figs. 1-6) is associated with a large and varied fauna in which the Gastropoda and Cephalopoda are strongly developed. It thus appears to belong in a later fauna than the Jordan. *Calvinella tenuisculpta* from the lower Pogonip limestone of Nevada is also from about the same horizon as *C. ozarkensis*. With it are associated the following:

(Locality 201a) "Lower Ordovician" (Ozarkian or Canadian): Pogonip limestone, east slope of the ridge east of Hamburg Ridge, Eureka district, Eureka County, Nevada (C. D. Walcott, 1882):

<i>Obolus</i> (<i>Ivestonia</i>) <i>iphis</i> Walcott	<i>Apatokephalus</i> <i>finalis</i> (Walcott)
<i>Lingulella</i> <i>pogonipensis</i> (Walcott)	<i>Conokephalina</i> <i>inexpectans</i> (Walcott)
<i>Acrothele</i> sp.	
<i>Acrotreta</i> <i>idahoensis</i> Meek	<i>Agraulos</i> ? <i>annectans</i> (Walcott)
<i>Schizambon</i> <i>typicalis</i> Walcott	<i>Anomocarella</i> <i>oweni</i> Meek and Hayden
<i>Eoorthis</i> <i>hamburgensis</i> Walcott	
<i>Syntrophia</i> <i>nundina</i> Walcott	<i>Amphion</i> ?? sp. undt.
<i>Tellinomya</i> ? <i>hamburgensis</i> Walcott	<i>Chuangia</i> <i>mccoyi</i> Walcott
<i>Agnostus</i> <i>prolongus</i> Hall and Whitfield	<i>Illenurus</i> ? <i>eurekensis</i> Walcott
	<i>Asaphus</i> ? <i>caribouensis</i> Walcott

Traces of *Dikelocephalus* are found in the southern Mississippi area in Oklahoma and Texas in the Upper Cambrian. The associated fauna in Texas includes *Saukia fallax* and in addition the following:

(Locality 70a) (below the fauna of locality 70) Upper Cambrian: Wilberns formation; Baldy Mountain, near Morgan's Creek, 8 miles (12.8 km.) northwest of Burnet, Burnet County, Texas (C. D. Walcott, 1884).

<i>Billingsella</i> <i>coloradoensis</i> (Shumard)	<i>Dikelocephalus</i> <i>texanus</i> Walcott
<i>Nileus</i> ? <i>dia</i> (Walcott)	<i>Saukia</i> <i>fallax</i> Walcott
<i>Lonchocephalus</i> <i>wisconsinensis</i> Owen	<i>Osceolia</i> <i>osceola</i> (Hall)

Dikelocephalus.—Of the seven species referred to the genus *Dikelocephalus* as restricted in this paper the stratigraphic position of all is known with the exception of *D. ? dalyi* n. sp. The type species of the genus, *D. minnesotensis* Owen, is recorded in literature as occurring at many localities, but I have inserted in this paper only those localities represented in the United States National Museum collections. It will be necessary to have more systematic and careful stratigraphic work and collecting done before any more accurate statement can be made.

Dikelocephalus minnesotensis Owen as now restricted does not occur in the supposed Jordan formation fauna exposed about Devils Lake, Wisconsin. The genus is there represented by a variety of *D. ? limbatus*. The typical form of this species occurs in the upper St. Lawrence beds at Osceola (78, 78b). There are fragments of a large trilobite that suggest *D. minnesotensis* at Osceola, but the identification is too uncertain to be of value. As far as known to me, *D. minnesotensis* does not occur in the Madison sandstone of the post-Cambrian. The species is found at the following, among other localities, in association with other genera and species as given in the following lists:

(Locality 85) Upper Cambrian: St. Lawrence formation at Prairie du Sac, Sauk County, Wisconsin (Cooper Curtice, 1884).

<i>Obolus (Westonia) aurora</i> (Hall)	<i>Owenella antiquata</i> (Whitfield)
<i>Obolus (Westonia) stoneanus</i> (Whitfield)	<i>Dikelocephalus minnesotensis</i> Owen
<i>Lingulella mosia</i> (Hall)	<i>Saukia crassimarginata</i> (Whitfield)
<i>Lingulella oweni</i> (Walcott)	<i>Saukia lodensis</i> (Whitfield)
<i>Lingulella winona</i> (Hall)	<i>Saukia pepinensis</i> (Owen)
<i>Lingulella winona convexa</i> (Walcott)	<i>Illænurus quadratus</i> Hall
	<i>Aglaspis barrandei</i> Hall
	<i>Aglaspis eatoni</i> Whitfield

(Locality 86) Upper Cambrian: St. Lawrence formation at Van Ness quarry, Gibraltar Bluff, Lodi, Columbia County, Wisconsin (L. C. Wooster, 1883; Cooper Curtice, 1884).

<i>Obolus (Westonia) aurora</i> (Hall)	<i>Saukia lodensis</i> (Whitfield)
<i>Lingulella mosia</i> (Hall)	<i>Illænurus quadratus</i> Hall
<i>Lingulella oweni</i> (Walcott)	<i>Aglaspis barrandei</i> Hall
<i>Dikelocephalus minnesotensis</i> Owen	

(Locality 113) Upper Cambrian: St. Lawrence formation at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota (Cooper Curtice, 1884).

<i>Lingulella mosia</i> (Hall)	<i>Triarthrella auroralis</i> Hall
<i>Lingulella winona</i> (Hall)	<i>Ptychaspis</i> sp. ?
<i>Serpulites murchisoni</i> Hall	<i>Dikelocephalus minnesotensis</i> Owen
<i>Owenella vaticina</i> (Hall)	<i>Saukia pepinensis</i> (Owen)

Saukia.—The genotype of the genus, *Saukia lodensis*, occurs only in the Upper Cambrian St. Lawrence formation. It is associated at localities 85 and 86 with the species listed above.

Saukia crassimarginata has a somewhat greater vertical range as it occurs with *S. lodensis*, and also in the overlying Jordan sandstone. At locality 78b it is associated with the following species:

Upper Cambrian: (78b) St. Lawrence formation, 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County, Wisconsin (Cooper Curtice, 1884).

<i>Lingulella mosia</i> (Hall)	<i>Dikelocephalus minnesotensis</i> Owen ?
<i>Lingulella similis</i> (Walcott)	<i>Saukia crassimarginata</i> (Whitfield)
<i>Finkelnburgia osceola</i> (Walcott)	<i>Osceolia osceola</i> (Hall)
<i>Owenella</i> cf. <i>antiquata</i> (Whitfield)	<i>Illænurus quadratus</i> Hall
<i>Dikelocephalus</i> ? <i>limbatus</i> Hall	

Saukia pepinensis (Owen) is found abundantly in the St. Lawrence formation (113, p. 360).

Saukia fallax (Locality 70a, p. 359) from Texas appears to be an Upper Cambrian species restricted to one locality and horizon as far as now known.

Saukia leucosia and *S. pyrene* both occur in the upper portion of the St. Lawrence formation at locality 78 in the following association:

Locality 78: Upper Cambrian: St. Lawrence formation; quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin (L. C. Wooster, 1883).

<i>Obolus</i> (<i>Westonia</i>) <i>aurora</i> (Hall)	<i>Spirodoentalium osceola</i> Walcott
<i>Lingulella mosia</i> (Hall)	<i>Owenella antiquata</i> (Whitfield)
<i>Lingulella mosia osceola</i> (Walcott)	<i>Holoepa</i> ? <i>sweeti</i> Whitfield
<i>Lingulella winona</i> (Hall)	<i>Ophileta</i> (<i>Raphistoma</i>) <i>primordialis</i>
<i>Lingulella winona convexa</i> (Walcott)	A. Winchell
<i>Billingsella coloradoensis</i> (Shumard)	<i>Dikelocephalus</i> ? <i>limbatus</i> Hall
<i>Finkelnburgia finkelnburgi</i> (Walcott)	<i>Saukia leucosia</i> Walcott
<i>Finkelnburgia osceola</i> (Walcott)	<i>Saukia pyrene</i> Walcott
<i>Finkelnburgia osceola corrugata</i>	<i>Osceolia osceola</i> (Hall)
(Walcott)	<i>Illænurus quadratus</i> Hall
<i>Syntrophia barabuensis</i> (A. Winchell)	

Saukia marica is at the upper line of the Cambrian in Nevada. At locality 62 it is associated with the following:

Upper Cambrian: (62) Limestone in the Dunderberg shale in canyon immediately north of Adams Hill, Eureka district, Eureka County, Nevada (C. D. Walcott, 1880).

<i>Micromitra sculptilis</i> Meek	<i>Agnostus prolongus</i> Hall and Whitfield
<i>Obolus discoideus</i> (Hall and Whitfield)	<i>Pagodia breviceps</i> ? (Walcott)
<i>Lingulella manticula</i> (White)	<i>Saukia marica</i> (Walcott)
<i>Lingulella punctata</i> (Walcott)	<i>Arcthusina</i> ? <i>americana</i> Walcott
<i>Acrotreta spinosa</i> Walcott	
<i>Agnostus communis</i> Hall and Whitfield	

Both *Saukia stosci* and *S. wardi* occur in the great Cambro-Ordovician limestones of the Appalachian region at about the horizon of the upper limit of the Upper Cambrian or possibly Lower Ozarkian.

Osceolia.—*Osceolia osceola* is associated with the St. Lawrence fauna in Wisconsin (Localities 78 and 83¹, see lists of fauna, pp. 356, 361). In Texas (Locality 70a, p. 359) and Nevada it is identified from the Upper Cambrian. In Nevada it occurs (Locality 66) with the following species:

Upper Cambrian: (66) Dunderberg shale, on the first ridge north of the Dunderberg mine, Eureka district, Eureka County, Nevada (C. D. Walcott, 1880).

<i>Obolus discoideus</i> (Hall and Whitfield)	<i>Agnostus tumidosus</i> Hall and Whitfield
<i>Agnostus communis</i> Hall and Whitfield	<i>Lisania angustifrons</i> Walcott
<i>Agnostus prolongus</i> Hall and Whitfield	<i>Osceolia osceola</i> (Hall)
	<i>Euloma affinis</i> Walcott
	<i>Arethusina ? americana</i> Walcott

Calvinella.—This genus is essentially one of the transition forms between Cambrian and Ozarkian. *Calvinella spiniger* is known only with the St. Lawrence fauna (p. 356). *Calvinella ozarkensis* in the Eminence fauna, *C. newtonensis* in the Kittatinny limestone, and *C. tenuisculpta* in the lower Pogonip limestone (p. 359).

Calvinella newtonensis occurs with the following species at locality

11c:

Lower Ozarkian: (11c) Lower part of Kittatinny limestone, O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey (H. E. Dickhaut, 1901).

<i>Obolus (Westonia) stoneanus</i> (Whitfield) variety or n. sp.	<i>Ptychoparia newtonensis</i> Weller
<i>Eoorthis newtonensis</i> (Weller)	<i>Anomocare ? parvula</i> Weller
	<i>Calvinella newtonensis</i> (Weller)

Conocephalina.—This genus occurs only in the upper beds of the Franconia formation. The one species, *C. misa* (Hall), has been found in association with species of trilobites of the genera *Chariocephalus*, *Lonchoccephalus*, *Ptychaspis*, and *Ptychoparia*, and the brachiopod *Billingsella coloradoensis*.

DESCRIPTION OF GENERA AND SPECIES

Genus DIKELOCEPHALUS¹ Owen

- Dikelocephalus* OWEN, 1852, Rep. Geol. Surv. Wis., Iowa, and Minn., p. 573. (Description of genus and observations.)
- Dikelocephalus* OWEN, BARRANDE, 1853, Neues Jahrb. für Min., Geol. und Geog., p. 336. (Comments on relation of *Dikelocephalus* to *Ogygia*.)
- Dikelocephalus* OWEN, EMMONS, 1855, American Geol., Vol. 1, pt. 2, p. 220. (Summarizes Owen's description of genus.)
- Dikelocephalus* OWEN, BILLINGS, 1860, Canadian Nat. Geol., Vol. 5, p. 306. (Comments on genus and refers several species to it.)
- Dikelocephalus* OWEN, HALL, 1863, Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., p. 137. (Reprints Owen's description, comments on the genus and describes three new species.)
- Dicellocephalus* OWEN, DANA?, 1864, American Journ. Sci. and Arts, 2d ser., Vol. 37, p. 139. (Changes spelling of name. The article is unsigned but was in all probability written by Prof. James D. Dana.)
- Dikelocephalus* OWEN, BILLINGS, 1865, Geol. Surv. Canada, Pal. Fossils, Vol. 1, p. 399. (Reprints remarks of 1860, noted above.)
- Dikelocephalus* OWEN, SALTER, 1866, Mem. Geol. Surv. Great Britain, Vol. 3, p. 303. (Comments on genus and refers four species to it.)
- Dikelocephalus* OWEN, HALL, 1867, Trans. Albany Inst., Vol. 5, p. 116. (Reprint of article of 1863.)
- Dikellocephalus* OWEN, HALL and WHITFIELD, 1877, U. S. Geol. Expl. 40th Parallel, Vol. 4, p. 225. (Mentions genus and refers three new species to it.)
- Dicellocephalus* OWEN, WHITFIELD, 1878, Ann. Rep. Wisconsin Geol. Surv. for 1877, p. 63. (Notes finding of uncompressed specimens of genus and refers two new species to it.)
- Dikelocephalus* OWEN, SALTER, 1881, Mem. Geol. Surv. Great Britain, Vol. 3, 2d ed., p. 497. (Reprint of paper of 1866.)
- Dikellocephalus* OWEN, WHITFIELD, 1882, Geol. Wisconsin, Vol. 4, p. 200. (Reprint of paper of 1878, with illustrations of the two species described under the genus.)
- Dikellocephalus* OWEN, DAMES, 1883, China, Richthofen, Vol. 4, pp. 5, 6. (Comments on species referred to genus.)
- Dicellocephalus* OWEN, MATTHEW, 1893, Trans. Royal Soc. Canada, Vol. 10, Sec. 4, p. 10. (Discusses the geographic and stratigraphic distribution of the genus and the validity of the generic reference.)
- Dikellocephalus* OWEN, BRÖGGER, 1897, Nyt Mag. for Naturvid., Vol. 36, pp. 179, 182, 183. (Discusses questions of species that have been referred to the genus.)
- Dikelocephalus* OWEN, BEECHER, 1897, American Journ. Sci., 4th ser., Vol. 3, p. 192. (Classifies *Dikelocephalus* as the type of a subfamily of the Olenidæ to be known as *Dikelocephalinæ*.)

¹Under the rule that, "The original orthography of the name is to be rigidly preserved unless a typographical error is evident," Owen's spelling of *Dikelocephalus* is followed. From Gr. *δίκελος*, a mattock or two-pronged hoe, and *κεφαλή*, head. *Dikelocephalus* has been called "shovel-head" (Chamberlin, 1883, Geol. Wisconsin, 1873-79, Vol. 1, p. 131).

Dicellocyphalus Owen, BERKEY, 1898, American Geol., Vol. 21, p. 290. (Discusses forms related to *D. misa* Hall.)

Generic description.—General form, a broad ellipse, moderately convex with pleural lobes more or less flattened, cephalon transverse; genal angles extended into spine: cranidium roughly subquadrangular in outline, with narrow fixed cheeks and strong palpebral lobes posterior to the rounded outer rim of the palpebral lobes extending across the fixed cheeks as narrow ocular ridges. Glabella subquadrangular in outline, and narrowing slightly towards its broadly rounded front; posterior furrow strong and extending across the glabella; second furrow indicated by a pair of short side furrows; a third furrow is indicated; strong flattened occipital ring.

Facial sutures as shown by figures 1, 2, and 5, plate 61.

Thorax with probably twelve segments as in the closely related genus *Saukia* (pl. 65). Axial lobe convex; pleural lobes depressed and with each segment having a narrow, oblique furrow that begins near the inner anterior margin and terminates well out and near the posterior margin of the backward curving more or less bluntly pointed extremity.

Pygidium transverse, large and with a strong central axis that terminates within a broad flattened border: it is marked by clearly defined transverse rings that extend out as the pleural lobes and broad border. The margin may or may not have two short posterolateral spines.

Surface with fine irregular more or less inosculating lines and, on some species, small granules over the glabella and median axis of the thorax and pygidium. It is punctate in *D. hartti* and *D. texanus*, the only two species in which the structure of the test is preserved.

Some of the species of *Dikelocyphalus* attain a large size. Specimens of the cephalon of *D. minnesotensis* in the collection of the United States National Museum have a length of 9 cm. and a width of 24 cm. Pygidia occur 9.5 cm. in length, 18 cm. in width, and a thoracic segment has a length of 16 cm. *Dikelocyphalus vanhornei* (pl. 62) is also a large species.

Genotype.—*Dikelocyphalus minnesotensis* Owen, 1852.

Stratigraphic range.—Upper beds of Upper Cambrian.

Geographic distribution.—Upper Mississippi Valley in western Wisconsin and eastern Minnesota, also in central Texas, Nevada and Montana. About the Adirondack Mountains of New York, in Saratoga and Franklin Counties and in central British Columbia. There are many references in literature to the occurrence of *Dikelocyphalus* in various parts of America and in foreign countries, but with the

limitations now given the genus, it is restricted to the areas mentioned above. It is quite probable that with more thorough collecting, it will be found along the front range of the Rocky Mountains.

It does not occur in the St. Lawrence Valley of Canada, but fragments of what may be a species of the genus occur in the Champlain Valley in Franklin County, northwestern Vermont, both in the Upper Cambrian limestone (Locality 87) and the superjacent limestone conglomerate (Locality 162).

Dimensions.—This genus includes the largest species of the *Dikelocephalinae*. One cranium has a length of 9 cm. and width of 9 cm. at the palpebral lobes. If to this were added the proportional wide free cheeks, the width of the cephalon at its posterior margin would be 24 cm. A pygidium has a width of 18 cm. with length of 9.5 cm.

A fragment of a large thoracic segment, preserving the pleural lobe has a length of 18 cm. with a longitudinal width of 1.5 cm.

On the basis of the above parts an entire trilobite of this genus evidently existed 32 cm. in length with a width of 24 cm.

Observations.—The earliest illustrations of the genotype of *Dikelocephalus*, *D. minnesotensis*, are on a plate accompanying a report by Dr. David Dale Owen, published in 1848.¹ The plate faces page 58 of the report and the specimens are referred to the genus *Asaphus*. These include the cranium and pygidium of a large trilobite that was in 1852 placed under the genus *Dikelocephalus*.

Dr. Owen (1852) did not have any entire specimens, but from the resemblance of fragments of *Dikelocephalus* to *Ogygia* he compared the genus with the latter and thought it probable that the number of thoracic segments was eight as in *Ogygia*. He described, illustrated, and named five species, *D. minnesotensis*, *D. pepinensis* (= *Saukia*), *D. miniscaensis* (= *Ptychaspis*), *D. granulosus* (= *Ptychaspis*), and *D. iowensis* (= *Crepicephalus*).

Dr. E. Billings (1869) noted that he thought the doublure beneath the head of *Dikelocephalus* was continuous and was not cut by the facial suture. He referred several new species to the genus, *D. magnificus* (= *Apatokephalus* ??), *D. planifrons* (= *Anomocare*), *D. belli* (= *Anomocarella*), *D. oweni* (= *Anomocare*), *D. megalops* (= *Anomocarella* ?), *D. cristatus* (= *Ptychaspis*).

Dr. James Hall reviewed the genus in 1863 and referred three new species to it, *D. spiniger* (= *Saukia*), *D. missa* (= *Conocephalina*), *D. osceola* (= *Osceolia*), and illustrated them from fragmentary

¹ Report of a Geological Reconnaissance of the Chippewa Land District of Wisconsin, etc. Senate Doc. Exec. No. 57, 30th Congress, 1st Session, 1848, p. 15, pl. 7, figs. 2, 3.

specimens. Dr. Owen's species, *D. granulosus* and *D. miniscaensis*, were placed in the genus *Ptychaspis*, and *D. iowensis* under *Conocephalites*.

In a review of Hall's work of 1863 in the American Journal of Science and Arts, the writer (probably James D. Dana) calls attention to the spelling of the name *Dikelocephalus* and states that the true orthography is *Dicellocephalus*.

In 1866 Mr. J. W. Salter gave a very brief interpretation of *Dikelocephalus* and referred four species to it: *Dikelocephalus* (*Centropleura* ?) *furca* (= *Dikelocephalina* Brögger ??), *Dikelocephalus celticus* (= Distorted pygidia, genus ?), *D. ?* (*Centropleura* ?) *discordalus* (= Perhaps *Anomocare* ?), *D. ?* (*Centropleura* ?) sp. (= *Anomocare* ?).

Messrs. Hall and Whitfield (1877) mention the genus in connection with the reference of two forms of pygidium of three species to it. The first, *D. bilobatus*, has the generic name *Pteroccephalus* bracketed with it in the description of the plate, but it is probably a species of *Anomocare*. The other two species, *D. multinctus* and *D. flabellifer* may be referred to *Apatokephalus* ? (= Brögger, 1897).

In 1878 Prof. R. P. Whitfield noted the occurrence of specimens of trilobites preserving their natural convexity that he referred to "*Dikellocephalus*," as *D. barabuensis* (= *Platycolpus*) and *D. eatoni* (= *Platycolpus*). This matter was reprinted in 1882 with illustrations of the species.

Dr. W. Dames (1883, pp. 5, 6) calls attention to the confusion existing among the species referred to "*Dikellocephalus*" and suggests the establishing of a new genus for Owen's *D. pepinensis*. He comments favorably on Hall's references, but calls attention to the less careful work of Billings.

Dr. G. F. Matthew (1893) attempted in a general manner to discuss the value of the generic reference of the many species that had been placed under *Dikelocephalus* by authors and to draw conclusions on the supposed stratigraphic position of the genus. He concluded that in America it was strictly a Cambrian genus, and in Europe Ordovician.

In 1896 Dr. Brögger followed up a previous suggestion that he had made and placed several species that had been referred to *Dikelocephalus* under the new genera *Diklocephalina*, *Conocephalina*, and *Apatokephalus*.

Dr. Beecher (1897) constituted the subfamily *Dikelocephalinæ* to include *Dikelocephalus* and allied genera.

In 1913, Dr. P. E. Raymond proposed the genus *Platycolpus* and referred Whitfield's species *Dikelocephalus barabuensis* and *D. eatoni* to it.¹

The species now referred to the genus as restricted are :

- Dikelocephalus minnesotensis* Owen (pls. 60, 61, 62, 65)
- Dikelocephalus minnesotensis* var. undt. (pl. 61, fig. 4)
- Dikelocephalus* ? *dalyi* Walcott (pl. 64, figs. 1-5)
- Dikelocephalus hartti* (Walcott) (pl. 63, figs. 1-7, 7a)
- Dikelocephalus* ? *limbatus* Hall (pl. 65, figs. 5-8)
- Dikelocephalus texanus* Walcott (pl. 65, fig. 4)
- Dikelocephalus* ? *tribulis* Walcott (pl. 63, figs. 8-10, 10a)
- Dikelocephalus vanhornei* Walcott (pl. 62, figs. 1-3)
- Dikelocephalus* sp. undt.² (loc. 151)

DIKELOCEPHALUS ? DALYI, new species

Plate 64, figs. 1-5

This fine species is founded on fragments of a large trilobite that include the cranidium, portions of thoracic segments and nearly entire pygidia which occur in limestone nodules embedded in a calcareous shale.

The smaller cranidia have the general outline of some of the species of *Anomocare* and *Anomocarella* from the Chinese Cambrian,³ but the larger specimens have the broad, flattened frontal limb of *Dikelocephalus*. (Compare fig. 2, pl. 64, and fig. 5, pl. 61.) The palpebral lobe of *D. dalyi* is shorter than in typical *Dikelocephalus*, in this respect resembling some species of *Anomocare*, but not the typical species, *Anomocare laeve* Angelin. The glabella is also much like that of *Anomocare*, but it might be included under *Dikelocephalus* by its outline and strong occipital furrow and long posterior glabella furrows. The associated free cheek might be referred to either genus as it has the general characters of each.

The fragments of the thoracic segments are similar to corresponding parts of the thoracic segments of *Dikelocephalus* and, to a less degree, of *Anomocare*.

The associated pygidia are essentially the same as the pygidium of *Dikelocephalus hartti* (pl. 63) and *D. minnesotensis*, with the exception of not having the two marginal spines of the latter species.

Dikelocephalus ? *dalyi* attains a much larger size than any known species of *Anomocare*, in this being comparable with *Dikelocephalus*.

¹ Geol. Survey Canada, Victoria Mem. Mus., 1913, Bull. 1, pp. 63, 64.

² See footnote ², p. 391, this paper.

³ Research in China, Vol. 3, Carnegie Institution of Washington, Pub. No. 54, 1913, The Cambrian Faunas of China, pls. 18 and 19.

Fragments of the pygidium indicate a width of 20 cm. at the anterior margin, which is about twice the size of the pygidium of *D. vanhornei* represented by figure 3, plate 62.

The surface is marked by fine, raised, more or less irregular lines or sharp ridges that are subparallel to the outer margin of the border of the cephalon and pygidium and to the margins of the thoracic segments. These lines also probably occur on the glabella. Punctae similar to those of the test of *Dikelocephalus* are indicated.

This species appears to indicate a genus intermediate in character between *Dikelocephalus* and *Anomocare*. In the absence of good specimens it is referred tentatively to *Dikelocephalus*. The only associated species is *Illanurus elongatus* n. sp.

The specific name is given in recognition of the discovery of the species by Dr. Reginald A. Daly.

Formation and locality.—Upper Cambrian: (346e) limestone nodules in calcareous shales in rock cut on Canadian Pacific Railway, 54.5 miles (87.2 km.) west of Field, and 2 miles (3.2 km.) west of Donald Station, British Columbia, Canada (R. A. Daly, 1912).

DIKELOCEPHALUS HARTTI (Walcott)

Plate 63, figs. 1-7, 7a

Conoccephalites hartti WALCOTT, 1879, Thirty-second Ann. Rept. New York State Mus., p. 130. (Original description of species.)

Dicellocephalus hartti (WALCOTT), 1886, Bull. U. S. Geol. Survey, No. 30, p. 21. (Name used in lists of species.)

Dicellocephalus hartti (Walcott), LESLEY, 1889, Geol. Surv. Pennsylvania, Rept. P4, Dictionary of Fossils, Vol. 1, p. 199. (Text figures reproduced from drawings sent him by Walcott.)

Dicellocephalus hartti (WALCOTT), 1912, Smithsonian Misc. Coll., Vol. 57, No. 9, p. 273, pl. 44, figs. 1-7, 7a. (Describes, illustrates, and comments on species.)

A description with comments on this species has been recently published (Walcott, 1912). The only additional information is to note the occurrence of several pygidia that appear to be identical with those illustrated on plate 63, figures 6, 7 of this species, in the upper layer of the Potsdam formation on Marble River, north of the Adirondack Mountains in New York.

Formation and locality.—Upper Cambrian: Hoyt formation; (76) arenaceous limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, and (76a) in a railroad quarry, 1 mile (1.6 km.) north of Saratoga Springs, both in Saratoga County (C. D. Walcott

and Cooper Curtice, 1883); also (111), at the top of the Potsdam sandstone on Marble River, 1 mile (1.6 km.) south of Chateaugay, Franklin County (C. D. Walcott, 1886), all in New York.

DIKELOCEPHALUS ? LIMBATUS Hall

Plate 65, figs. 5-8

Dikelocephalus minnesotensis var. *limbatus* HALL, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 141, pl. 9, fig. 12. (Describes and illustrates anterior portion of a cranidium.)

Dikelocephalus minnesotensis Owen, WINCHELL, 1864, American Journ. Sci., 2d ser., Vol. 37, p. 229. (Remarks on occurrence of a species of *Dicelloccephalus* doubtfully referred to this species.)

Dikelocephalus minnesotensis var. *limbatus* HALL, 1867, Trans. Albany Inst., Vol. 5, p. 121, pl. 4, fig. 12. (Reprint of paper of 1863.)

This very interesting species is represented by several fragments from locality 78 where the cranidium represented by figure 6 is associated with the pygidium represented by figure 7. The broad, slightly concave, frontal limb and subquadrilateral glabella bring the species close to *Dikelocephalus* as does the associated pygidium. The latter has the relatively short axial lobe and broad flattened border of the pygidia of *D. minnesotensis*, but it differs in the details of the furrows on the pleural lobes and in the absence of spines on the margin.

Dr. James Hall considered the fragment that he described as a variety of *D. minnesotensis*, but with the specimens now available for study the varietal name *limbatus* is used as the specific name.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (78) quarry near St. Croix River, in suburbs of Osceola, Polk County (L. C. Wooster, 1883); (78b) 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County (Cooper Curtice, 1884), and (134a) in a quarry 1 mile (1.6 km.) southeast of the county court house, in Menomonie, Dunn County (Chas. Schuchert, 1893), all in Wisconsin.

A number of specimens of the pygidium and free cheeks of a species closely related to *D. ? limbatus* occur in the Jordan sandstone (81b), near Devils Lake, Sauk County (Cooper Curtice, 1884). These are the forms described by Dr. Alexander Winchell. One of the pygidia is illustrated by figure 8, plate 65.

DIKELOCEPHALUS MINNESOTENSIS Owen

Plate 60, figs. 1-8; plate 61, figs. 1-3, 5-7; plate 62, figs. 4-6; plate 66, fig. 1.

Asaphus OWEN, 1848, Rept. Geol. Reconnaissance, Chippewa Land District, Senate Doc., Exec. No. 57, 30th Congress, p. 15, pl. 7, figs. 2, 3. (Illustrates cranidium and pygidium under name *Asaphus*.)

- Dikelocephalus minnesotensis* OWEN, 1852, Rept. Geol. Survey Wis., Iowa, and Minn., p. 574, pl. 1, figs. 1, 2; pl. 1a, figs. 3, 6. (Description and illustrations of species. Fig. 10, pl. 1, is now referred to *D. crassimarginatus*.)
- Ogygia minnesotensis* (Owen), CHAPMAN, 1856, Canadian Journ., new ser., Vol. 1, p. 275. (Refers species to *Ogygia*.)
- Dikelocephalus minnesotensis* Owen, MACKIE, 1859, The Geologist (London), Vol. 2, p. 189, fig. 4. (Text figure of Owen's restoration of the species.)
- Dikelocephalus minnesotensis* Owen, HALL, 1862, Rept. Geol. Survey Wisconsin, Vol. 1, p. 22, figs. 1, 2. (Illustrates a cranidium and a pygidium.)
- Dikelocephalus minnesotensis* Owen, HALL, 1863, Rept. Geol. Survey Wisconsin, p. 138, pl. 9, figs. 5-10; pl. 10, figs. 10-12; pl. 11, figs. 1, 3, and 4. (Species described and illustrated from fragmentary specimens.)
- Dikelocephalus minnesotensis* Owen, HALL, 1867, Trans. Albany Inst., Vol. 5, p. 117, pl. 4, figs. 5-10; pl. 5, figs. 10-12; pl. 6, figs. 1, 3, 4. (Reprint of paper of 1863.)
- Dikellocephalus minnesotensis* Owen, WHITFIELD, 1882, Geol. Wisconsin, 1873-79, Vol. 4, p. 187, pl. 3, fig. 1. (Describes species and illustrates a pygidium.)
- Dicellocephalus minnesotensis* Owen, WALCOTT, 1886, Bull. U. S. Geol. Survey, No. 30, p. 35, par. 66. (Notes occurrence of species in Highland Range, Nevada.)
- Dicellocephalus minnesotensis* Owen, LESLEY, 1880, Geol. Survey Pa., Rept. P. 4, Dictionary of Fossils, Vol. 1, p. 198, fig. 1. (Reproduces figures from Owen.)
- Dicellocephalus minnesotensis* Owen, MILLER, 1889, North American Geol. and Pal., p. 544, text fig. 999. (Restored figure of entire dorsal shield.)
- Dikelocephalus minnesotensis* Owen (?), WALCOTT, 1891, Bull. Geol. Survey, No. 81, p. 235. (Notes probable occurrence of species in Texas in giving names of fossils.)
- Dikelocephalus minnesotensis* Owen, SARDESON, 1896, Bull. Minnesota Acad. Nat. Sci., Vol. 4, p. 95. (Mentions occurrence of species at localities in Minnesota.)

Dr. James Hall in 1863 published a detailed description of all that was known to him of the species, and practically nothing has been added since. No entire specimens of the dorsal shield are known to me. It is probable that there were 12 segments in the thorax as in *Saukia*, but this is uncertain.

The species is confined to the Mississippi valley as far as now known, with the possible exception of a locality in Lincoln County, Nevada, where fragments associated with *Saukia pepinensis* appear to indicate its presence.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (85) at Prairie du Sac, Sauk County (Cooper Curtice, 1884). and (86) at Van Ness quarry, Gibraltar Bluff, Lodi, Columbia County (L. C. Wooster, 1883; Cooper Curtice, 1884), both in Wis-

consin; also, (86b) hilltop, north end of city of Lansing, Allamakee County, Iowa (P. Bartsch, 1912).

Also from locality (83²), an upper horizon of the St. Lawrence formation near Trempealeau, Trempealeau County (Cooper Curtice and G. H. Squiers, 1884; Chas. Schuchert, 1893); (113) at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County (Cooper Curtice, 1884); (85b) bank of St. Croix River, Stillwater, Washington County, all in Minnesota.

Doubtful identifications.—From the upper beds of the old "St. Croix sandstone," or St. Lawrence formation.

(339f) Among fragments from the Upper Cambrian sandstones at Minneiska, Minnesota, on the Mississippi River, there is one of a large thoracic segment that may belong to this or an allied species.

At Localities 78 and 78b, Osceola, Wisconsin, a somewhat similar segment and a fragment of a large cranium (pl. 62, figs. 4, 6) indicate that a large species is present. Better specimens may prove that the material belongs to a distinct and undescribed species or to *Dikelocephalus limbatus*.

(78) Upper Cambrian: St. Lawrence sandstone series; quarry near St. Croix River, in suburbs of Osceola, Polk County (L. C. Wooster, 1883), and (78b) 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County (Cooper Curtice, 1884), both in Wisconsin; also (339f) near Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona counties, Minnesota (F. M. Brown).

DIKELOCEPHALUS MINNESOTENSIS var.

Plate 61, fig. 4

A variety of *D. minnesotensis* occurs at La Grange mountain (Locality 113) that is represented by the pygidium illustrated by figure 4, plate 61. This has four rings on the median lobe and four segments outlined on the pleural lobes, while *D. minnesotensis* has seven or eight rings on the median lobe and eight or ten segments outlined on the pleural lobes (pl. 61, fig. 6). A second pygidium possibly of this variety comes from Osceola at a horizon higher as indicated by the associated fauna.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (113) sandstone at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota (Cooper Curtice, 1884), and (78b) 50 feet (15.2 m.) above the St. Croix River, near the landing at Osceola, Polk County, Wisconsin (Cooper Curtice, 1884).

DIKELOCEPHALUS TEXANUS, new species

Plate 65, fig. 4

Of this species only the fragment of the posterior half of the cranium illustrated has been seen. This indicates a large form comparable with *Dikelocephalus minnesotensis*. It differs from that in having the palpebral lobe farther forward, and from *D. vanhornei* in having the palpebral lobe nearer the glabella. With better specimens probably other differences might be found.

The outer test has been exfoliated, but from the impression of the inner surface it is evident that it was marked by rather strong, narrow, irregular lines.

Formation and locality.—Upper Cambrian: (70a) Wilberns formation, Baldy Mountain, near Morgans Creek, 8 miles (12.8 km.) northwest of Burnet, Burnet County, Texas (C. D. Walcott, 1884).

Fragments of a large trilobite that may be a species of *Dikelocephalus* occur in the lower portion of the Arbuckle limestone of Oklahoma (12g), 150 miles (240 km.) north of the locality (70a) where *D. texanus* occurs. Unfortunately there is not sufficient material by which to compare the cranidia. The fragments at both localities indicate a large species comparable with *D. minnesotensis*.

DIKELOCEPHALUS ? TRIBULIS Walcott

Plate 63, figs. 8-10, 10a

Diceloccephalus tribulis WALCOTT, 1912, Smithsonian Miscellaneous Coll., Vol. 57, No. 9, p. 274, pl. 44, figs. 8, 8a. (Illustrates and comments on species.)

With only imperfect specimens of the cranium and a fragment of a pygidium doubtfully referred to the species, it is difficult to make a satisfactory generic reference. The position of the palpebral lobes and the slightly concave frontal limb suggest *Conocephalina misa* (Hall) (pl. 68, figs. 1, 2), while the form of the glabella is much like that of *Dikelocephalus hartti*. It may be that with the discovery of entire specimens of this species and *Conocephalina misa* the two will be found to be congeneric and an intermediate form between *Dikelocephalus* and *Saukia*.

The largest specimen of the cranium in the collection has a length of 16 mm.

Formation and locality.—Upper Cambrian: (76) Hoyt formation: arenaceous limestone at Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York (C. D. Walcott and Cooper Curtice, 1883).

DIKELOCEPHALUS VANHORNEI, new species

Plate 62, figs. 1-3

This is a fine, large species of which we have for study the cranium thoracic segments, and pygidium. The cranium is much like that of *D. minnesotensis*. It differs in having a proportionally shorter glabella and wider fixed cheeks. The thoracic segments are of the same type, but the pygidium is quite unlike that of *D. minnesotensis*. It is more transverse and has a larger axial lobe and a smoother margin unbroken by spines.

The type specimen of the cranium (fig. 1) has a length of 5.5 cm. and an associated pygidium (fig. 3) has a length of 4.6 cm. and width of 9.8 cm.

The specimens occur as casts in a fine-grained, yellowish gray, shaly sandstone and show only a few traces of a roughened surface on the cranium, and of fine raised, irregular lines on the flattened borders of the pygidium.

The specific name is given in recognition of the early work of Sir William Van Horne, who, as a young man, formed a collection of fossils in Wisconsin, which he subsequently presented to the Museum of McGill University, Montreal, Canada.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (346d) railroad dam at Hoka, Houston County, Minnesota. Type specimens in Walker Museum, University of Chicago. Pal. Coll. No. 14393.

Plastotype No. 346d, U. S. Nat. Mus., Cat. No. 58608.

While the above was in galley proof I received from Mr. W. A. Finkelnburg, of Winona, Minnesota, specimens of the pygidium of this species which were found in the bluffs near Winona.

Genus SAUKIA, new genus

General form elongate oval; moderately convex. Cephalon transversely semi-ovate with genal angles extended backward in strong spines. Axial and pleural lobes strongly outlined. Marginal border slightly rounded or nearly flat and merging into genal spines; posterior margin with a narrow, rounded, well-defined rim; occipital ring strong, nearly transverse.

Glabella subquadrangular; usually narrowing opposite the palpebral lobes by slight incurving of its sides; frontal margin broadly rounded; occipital furrow strongly defined; posterior glabellar furrow strong, second furrow less pronounced than the first, and not con-

nected at the center; third furrow usually faintly defined and represented by a short furrow on each side of the glabella that extends directly inward instead of slightly backward as in the first and second glabellar furrows. Free cheeks rather large and convex.

Palpebral lobe prominent, about one-half the length of the glabella; marked by a strong intramarginal furrow; anterior margin a little in advance of the transverse center of the glabella. Eye lobe narrow.

The facial sutures cut the posterior margin well out toward the genal spine and curve quickly inward to the posterior margin of the eye, outlining the narrow postero-lateral limbs of the cranidium; arching outward around the palpebral lobes they curve slightly outward and then inward so as to cut the front margin on a longitudinal line passing through the outer margin of the palpebral lobe.

Thorax with 12 segments. Axial lobe convex with each segment gently rounded and with a very faint longitudinal furrow on each side that serves to define a slight swelling at the end of each segment. Pleural lobes of nearly uniform width throughout and with each segment terminating in a short falcate end; pleural furrows narrow, deep, and crossing the pleuræ obliquely from the anterior inner end to the posterior third of the falcate terminal section.

Pygidium transversely and approximately semicircular with the anterior margin arched forward; strongly trilobed. Axial lobe convex, with four to eight transverse segments. Pleural lobes with flattened margin that is usually free from pleural and segmental furrows; surface marked by segmental lines and narrow pleural furrows of the same general character as the pleural furrows of the thoracic segments.

Surface pustulose as in *Saukia lodensis* (pl. 65, figs. 1, 2) to minutely granulose as in *Saukia pepinensis* (pl. 67).

Dimensions.—The largest specimen of the typical species is illustrated by figure 1, plate 65. None of the species referred to *Saukia* approaches in size *Dikelocephalus minnesotensis* (pl. 60).

Genotype.—*Dikelocephalus lodensis* Whitfield (pl. 65, fig. 1).

The genus *Saukia*¹ is proposed for a group of trilobites that have heretofore been referred to *Dikelocephalus*. It differs from the latter in having a comparatively narrow frontal limb to the cephalon; a proportionately longer glabella that may be narrowed opposite the palpebral lobes and slightly expanded anteriorly and that is more elongate proportionally than in *Dikelocephalus*. As far as known the

¹ Indian name *Sauk* applied to Sauk County, Wisconsin, in which localities specimens of *Saukia lodensis* occur.

thoracic segments of the two genera are similar. The pygidium of *Saukia* is less expanded and more elongate than that of *Dikelocephalus*.

Saukia differs from *Osceolia* (pl. 68, figs. 4-10) in having a concave instead of a depressed convex anterior margin to the cephalon, and a rounded, smooth margined pygidium.

It differs from *Calvinella* (pl. 69, figs. 1-5) in form of glabella, absence of a strong occipital spine, and proportionately less transverse pygidium. These characters may possibly be accompanied by other differences in the thorax not at present known.

The species now referred to the genus are:

- Saukia coloradoensis* Walcott (text figs. 13-16, p. 376)
- Saukia crassimarginata* (Whitfield) (pls. 61, 65, 66)
- Saukia fallax* Walcott (pl. 67, figs. 21, 21a, 22, 22a)
- Saukia junia* Walcott (text fig. 17, p. 378)
- Saukia* ?? *leptanarum* (Wiman)
- Saukia leucosia* Walcott (pl. 67, figs. 14-17)
- Saukia lodensis* (Whitfield) (pl. 65, figs. 1-3)
- Saukia marica* (Walcott) (pl. 64, figs. 6, 6a)
- Saukia pepinensis* (Owen) (pl. 67, figs. 1-13)
- Saukia pyrene* Walcott (pl. 67, figs. 18-20)
- Saukia rustica* Walcott (text figs. 18, 19, p. 383)
- Saukia stosei* Walcott (pl. 69, figs. 3-5)
- Saukia wardi* Walcott (pl. 69, figs. 1-2)

Stratigraphic range.—Found in both the upper and lower zones of the St. Lawrence formation and Lower Ozarkian.

Geographic distribution.—Several of the species are found in the upper Mississippi valley in Wisconsin and eastern Minnesota. *Saukia pepinensis* occurs in central eastern Nevada and *S. fallax* is from central Texas. *Saukia coloradoensis* occurs at Quandary Peak, Summit County, Colorado. Two species, *S. stosei* and *S. wardi*, are from the Appalachian Province in southwestern Pennsylvania and western Virginia.

Observations.—The species referred to *Saukia* fall into two groups. The first, characterized by *S. lodensis*, *S. coloradoensis*, and *S. crassimarginata*, which most nearly approach *Dikelocephalus*, except in the character of the frontal limb and margin. The second, characterized by *S. pepinensis* and its allies, *S. leucosia*, *S. pyrene*, *S. stosei* and *S. wardi*, which appear to be intermediate between *Dikelocephalus* and forms referred to *Anomocare*, but with a leaning towards *Dikelocephalus*. With the discovery of entire specimens of the several species it may be that a rearrangement of the generic references of the several species now placed under *Saukia* will be necessary.

SAUKIA COLORADOENSIS, new species

Text figures 13-16

Dicellosephalus minnesotensis?, 1886, Monogr. U. S. Geol. Survey, Vol. 12, p. 60. (Name mentioned in text. Label with specimens states that the identification was by R. P. Whitfield.)

This species is represented by fragmentary specimens of the cranium, free cheeks, thoracic segments, and pygidium. At first I referred it to *Saukia crassimarginata*, but on working the cranium and pygidium free from the covering matrix it was found to differ. The frontal limb is less convex and is marked by a slight

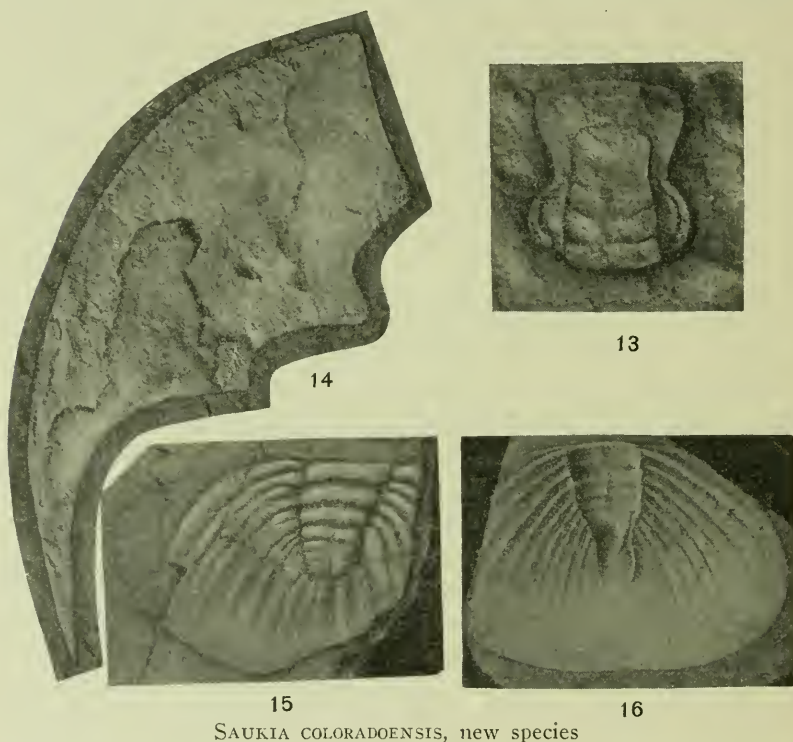


FIG. 13. ($\times 2$.) Cranium flattened in shale. Postero-lateral limbs restored. U. S. National Museum, Catalogue No. 60673.

FIG. 14. (Natural size.) Large free cheek with outline partly restored. U. S. National Museum, Catalogue No. 60674.

FIG. 15. (Natural size.) Pygidium with outline restored. U. S. National Museum, Catalogue No. 60675.

FIG. 16. (Natural size.) Matrix of pygidium with outline partly restored. U. S. National Museum Catalogue No. 60676.

transverse furrow that serves to outline a narrow flattened bordering rim. The associated pygidium has a longer axial lobe.

The specimens are all¹ from locality **20b**, Upper Cambrian; about 1 mile (1.6 km.) above Monte Cristo Mine, Quandary Peak, Summit County, Colorado (Whitman Cross, collector, 1880).

This is a large species and it may be the largest one of the genus. It is also of special interest owing to its geographic position. A careful search in the Upper Cambrian of the Leadville region may result in finding good specimens of this species and, of still greater importance, the fauna that accompanied the invasion of the Upper Cambrian sea in this region.

Formation and locality.—Upper Cambrian: (**20b**) about 1 mile (1.6 km.) above Monte Cristo Mine, Quandary Peak, Summit County, Colorado (Whitman Cross, collector, 1880).

SAUKIA CRASSIMARGINATA (Whitfield)

Plate 61, fig. 8; plate 65, figs. 9, 10; plate 66, figs. 2-5, 5a

Dikelocephalus (minnesotensis?) OWEN, 1852 (in part), Rept. Geol. Survey Wis., Iowa, and Minn., p. 574, Tab. 1, fig. 10. (Figure of cranidium doubtfully referred to *D. minnesotensis*.)

Dikelocephalus minnesotensis var. HALL, 1863 (in part), Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 141, pl. 9, fig. 11; pl. 10, fig. 9; pl. 11, fig. 2. (Two cranidia described and illustrated. Free cheek tentatively referred to *D. pepinensis*.)

Dikelocephalus minnesotensis var. HALL, 1867, Trans. Albany Inst., Vol. 5, pl. 4, fig. 11; pl. 5, fig. 9. (Reprint of figures of 1863.)

Dikelocephalus crassimarginatus WHITFIELD, 1882, Geol. Wisconsin, Vol. 4, p. 344, pl. 27, fig. 14. (Describes and illustrates free cheek as type of species.)

Dicellocephalus — CHAMBERLIN, 1883, Geol. Wisconsin (Survey of 1873-1879), Vol. 1, p. 129, text fig. 15. (Illustrates a nearly entire specimen from Prairie du Sac that is evidently this species.)

This fine species is generically related to *Saukia lodensis* (pl. 65, fig. 1). It differs specifically from it in having a broader border to the cephalon and pygidium, broader fixed cheeks, and smooth surface over the entire dorsal test. It also attains a larger size.

An entire specimen in the collection of the United States National Museum has a length of 9.7 cm., with a width of 6.8 cm. at the back of the cephalon. Other proportions are shown by figure 2, plate 66.

Several pygidia (pl. 65, fig. 9) resembling the pygidium of this species occur in the coarser Jordan? sandstone (**81**, **81b**) near Devils Lake. The specific identification must remain doubtful until speci-

¹ See also page 378, second species under *Saukia fallax*.

mens of the cephalon are found. A similar pygidium occurs in the upper beds of sandstone near Trempealeau: (83¹) Upper Cambrian: St. Lawrence formation; near Trempealeau, Trempealeau County, Wisconsin (Chas. Schuchert, 1893).

The western representative of this species is *Saukia coloradoensis*.

Formation and locality.—Upper Cambrian: St. Lawrence series; (85) at Prairie du Sac, Sauk County (Cooper Curtice, 1884); also (85x) beds near Mazomanie, Dane County (Chas. Schuchert, 1893); (78b) 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County (Cooper Curtice, 1884); and doubtfully (81) Jordan sandstone series, 1 mile (1.6 km.) east-northeast of Devils Lake, Sauk County (L. C. Wooster, 1883); (81b) Jordan? sandstone, near Devils Lake, Sauk County (Cooper Curtice, 1884), all in Wisconsin.

SAUKIA FALLAX, new species

Plate 67, figs. 21, 21a, 22, 22a

This species is represented by specimens of the cranidium. The form of the glabella and frontal rim relate it to *S. pepinensis*, *S. leucosia*, and *S. pyrene*, all of which are illustrated on the same plate. It differs from the nearly related *S. pyrene* and *S. wardi* (pl. 69, fig. 3) by having a slightly tapering glabella and smoother surface.

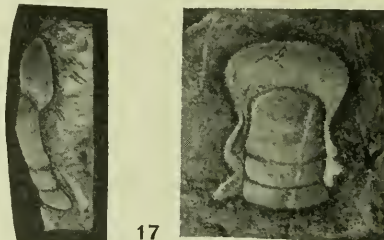
Formation and locality.—Upper Cambrian: (70a) Wilberns formation, Baldy Mountain, near Morgans Creek, 8 miles (12.8 km.) northwest of Burnet, Burnet County, Texas (C. D. Walcott, 1884).

A second species from Texas, not unlike *Saukia coloradoensis* (p. 376), is shown by fragments occurring in a shale from San Saba County.

SAUKIA JUNIA, new species

Text figure 17

This is a species allied to both *Saukia crassimarginata* (pl. 66) and *S. pepinensis* (pl. 67). It is represented by a broken cranidium



SAUKIA JUNIA, new species

FIG. 17. (Natural size.) Type specimen in limestone and side outline.
U. S. National Museum, Catalogue No. 60677.

22 mm. in length. The frontal limb is proportionally longer than that of either of the above species, and there is a peculiar flattening of the frontal border in advance of the glabella with a narrow transverse ridge outlining the broad, downward sloping frontal margin. The glabella expands a little anteriorly.

Surface of test apparently smooth.

Formation and locality.—Upper Cambrian: (12g: 50 feet above 12j) Arbuckle limestone (lower part); Wichita Mountains, south side about 8 miles (12.8 km.) west of Fort Sill and in a small hill 2 miles (3.2 km.) southwest of Signal Mountain, Comanche County, Oklahoma. Fossil horizon No. 3 of E. O. Ulrich, 100 feet (30.4 m.) from base of hill. Collected October 9, 1901.

SAUKIA ? ? LEPTÆNARUM (Wiman)

Dicellosephalus ? leptanarum Wiman, 1907, Arkiv för Zoologi, Bd. 3, No. 24, p. 5, pl. 2, figs. 1-3. (Described and illustrated as a new species.)

This species is founded on a small pygidium that resembles the pygidium of *Saukia leucosia* (pl. 67, figs. 13, 13a). It is possible but not probable that the pygidium belongs to a species of *Saukia*.

Formation and locality.—Ordovician: *Leptana* limestone, west Baltic region, Sweden.

SAUKIA LEUCOSIA, new species

Plate 67, figs. 14-17a

This fine species is represented by specimens of the cranidium, free cheeks, and possibly the pygidium. It differs from the associated *Saukia pyrene* (pl. 67, figs. 18-20) by having a broad, rounded frontal limb, a character that serves also to distinguish it from *S. pepinensis* (pl. 67, figs. 1-5) and *S. stosei* (pl. 69, fig. 3).

Formation and locality.—Upper Cambrian: St. Lawrence formation (78), quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin (L. C. Wooster, 1883).

Franconia formation (99), Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona Counties, Minnesota (Cooper Curtice, 1884).

SAUKIA LODENSIS (Whitfield)

Plate 65, figs. 1-3

Dikellosephalus lodensis WHITFIELD, 1880, Ann. Rept. Wis. Geol. Survey for 1879, p. 51. (Founds species on a free cheek.)

Dikellosephalus lodensis WHITFIELD, 1882, Geol. Wisconsin, Vol. 4, p. 188, pl. 10, fig. 14; p. 341; pl. 27, figs. 12-13. (Reprints former description and illustrates free cheek, and on pl. 27, figs. 12 and 13, a nearly entire dorsal shield.)

Dicelloccephalus lodensis Whitfield, CHAMBERLIN, 1883, Geol. Wisconsin, Vol. 1, p. 130, text figs. 16, 16a-b. (Illustrates nearly entire specimen of dorsal shield.)

The generic description of *Saukia* is based on this species; this with the figures on plate 65 gives a sufficiently complete conception of the species to furnish the student with the means for identifying and comparing it with other species. It differs from the other species referred to the genus by its strongly granulose surface and variations in details of form of the parts of the cephalon and pygidium.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (85) at Prairie du Sac, Sauk County (Cooper Curtice, 1884); (86) at Van Ness quarry, Gibraltar Bluff, Lodi, Columbia County (L. C. Wooster, 1883; Cooper Curtice, 1884), both in Wisconsin.

SAUKIA MARICA (Walcott)

Plate 64, figs. 6, 6a

Dicelloccephalus marica Walcott, 1886, Monogr. U. S. Geol. Surv., Vol. 8, p. 44, pl. 10, fig. 13. (Described as below.)

Glabella and fixed cheeks subquadrate in outline, narrowing somewhat towards the front. Glabella subquadrangular and almost squarely truncate in front, which is not quite as wide as the base; strongly convex, and marked by three pairs of furrows, the two anterior pairs but slightly depressed and very short; the posterior pair extend obliquely inward one-third the distance across from each side, and are united by a slight transverse furrow; occipital ring strong and elevated; occipital furrow well defined; dorsal furrows strongly impressed; fixed cheeks moderately convex, narrow in front, widening at the palpebral lobes, and sloping away rapidly in front, and less so back of the eye lobes; eye lobes narrow, semicircular, and situated opposite the central portion of the glabella; frontal limb obsolete except the round, thick, marginal rim just in advance of the glabella; the posterior limbs are broken away at a little distance from the dorsal furrows.

Surface as seen under a strong magnifying glass, with fine inosculating, flattened lines surrounding minute round or irregularly oval spaces.

Observations.—This species is represented by one specimen of the cranidium. It resembles the cranidium of *Saukia pyrene* (pl. 67, fig. 18) and *S. fallax* (pl. 67, fig. 21), but differs in its frontal border. It occurs in the closing epoch of the Cambrian in association with a well-marked fauna (see locality 62, p. 361).

Formation and locality.—Upper Cambrian (62) in thin layer of limestone in Dunderberg shale, in canyon immediately north of Adams Hill, Eureka District, Nevada¹ (C. D. Walcott, 1880).

SAUKIA PEPINENSIS (Owen)

Plate 67, figs. 1-13, 13a

Dikelocephalus pepinensis OWEN, 1852, Rept. Geol. Surv. Wis., Iowa, and Minn., p. 574, pl. 1, figs. 9, 9a-b. (Describes and illustrates species.)

Dikelocephalus pepinensis OWEN, HALL, 1862, Rept. Geol. Surv. Wis., Vol. 1, p. 22, text figs. 3, 4. (Illustrates cranidium and pygidium.)

Dikelocephalus pepinensis OWEN, HALL, 1863, Sixteenth Ann. Rept. State Cab. Nat. Hist., p. 142, pl. 9, figs. 1-4; pl. 10, figs. 14-17. (Describes in detail and illustrates species. Fig. 13 does not appear to belong with this species.)

Dicelloccephalus pepinensis OWEN, WINCHELL, 1864, American Journ. Sci., 2d ser., Vol. 37, p. 229. (Comments on cranidium and describes an associated pygidium.)

Dikelocephalus pepinensis OWEN, HALL, 1867, Trans. Albany Inst., Vol. 5, p. 122, pl. 4, figs. 1-4; pl. 5, figs. 14-17. (Republishes text and illustrations of 1863.)

Dicelloccephalus pepinensis OWEN, CHAMBERLIN, 1883, Geol. Wisconsin, Vol. 1, p. 130, figs. 16c-f, after Hall, 1863. (Copies figures of Hall without description.)

Dicelloccephalus pepinensis OWEN, WALCOTT, 1886, Bull. U. S. Geol. Survey, No. 30, p. 35, paragraph 66. (Notes occurrence of species in Highland Range, Nevada.)

Dikelocephalus pepinensis OWEN, BRÖGGER, 1897, Nyt Mag. for Naturvid., Vol. 36, p. 175, fig. 9. (Illustrates pygidium after Hall.)

This species is readily recognized by its strong, flattened frontal rim and convex compact pygidium with a narrow, slightly flattened border. The description, given by Hall in 1863, is so detailed and accurate that it does not appear necessary to attempt to add to it.

Fragments of the species occur in great abundance in the shaly sandstones of the upper horizon of the St. Lawrence sandstones of Wisconsin.

Comparisons with other species referred to *Saukia* are given under observations on the genus.

Specimens of a cranidium and a pygidium that appear to be identical with those from Wisconsin in the Highland Range of Nevada in a limestone in association with fragments of a large trilobite that indicates a species which may be *Dikelocephalus minnesotensis*.²

¹ In Monograph 8 of the U. S. Geological Survey, p. 45, the locality of the type specimen is incorrectly given as just south of the Hamburg Mine. The geological horizon is correct but not the exact locality.

² Bull. U. S. Geol. Survey, No. 30, 1886, p. 35, paragraph 66.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (113) at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County; also, (132) about 2 miles (3.2 km.) northwest of Lake City, on Lake Pepin, Wabasha County (Chas. Schuchert, 1893), all in Minnesota.

(85x) Near Mazomanie, Dane County, Wisconsin (Chas. Schuchert, 1893).

(88) Upper Cambrian: Hamburg formation (limestone), west side of Highland Range, 17 miles (27.2 km.) southwest of Pioche and 7 miles (11.2 km.) north of Bennetts Spring, Lincoln County, Nevada (C. D. Walcott, 1887).

A cranidium and free cheeks that may belong to a variety of this species occur in a friable sandstone with *Dikelocephalus* cf. *limbatus*, *Osceolia osceola* (Hall) and *Saukia leucosia* Walcott, near Devils Lake, Wisconsin. The parts are larger than in the typical specimens and it may be that another species is indicated.

Localities 81 and 81b, Upper Cambrian: Jordan? sandstone: 1 mile (1.6 km.) east-northeast of Devils Lake, Sauk County, Wisconsin (L. C. Wooster, 1883; Cooper Curtice, 1884).

SAUKIA PYRENE, new species

Plate 67, figs. 18-20

This species is represented by numerous fragments of the dorsal test including the cranidium, free cheeks and pygidium. At first sight the cranidium was referred to the Texas form of *Saukia fallax* (pl. 67, fig. 21), but closer comparison showed that its glabella was proportionally narrower and the sides more nearly parallel. The frontal rim is of the same character in the two species. The pygidium associated with *S. pyrene* (fig. 20, pl. 67) is unlike that associated with *S. fallax* in Texas (figs. 21, 21a, pl. 67).

Saukia pyrene differs from the associated *S. leucosia* (pl. 67, figs. 14-17) mainly in its rounded strong frontal limb. The frontal limb of *S. pepinensis* (pl. 67, figs. 1-5) is flattened and the glabella is proportionally wider than that of *S. pyrene*.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (78) quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin (L. C. Wooster, 1883).

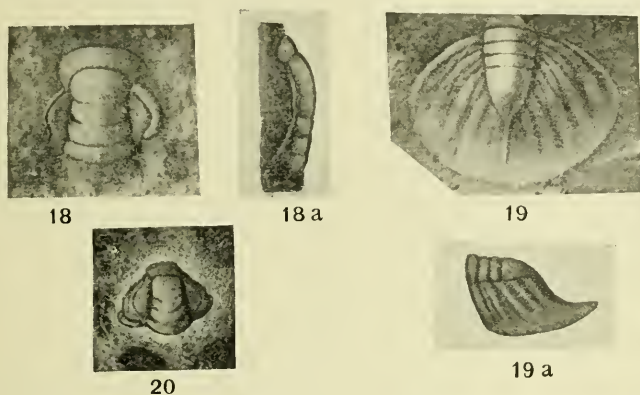
A somewhat similar form is indicated in the sandstone at Devils Lake by the presence of cranidia and free cheeks (81b): Jordan? sandstone: 1 mile (1.6 km.) east-northeast of Devils Lake, Sauk County, Wisconsin (L. C. Wooster, 1883; Cooper Curtice, 1884).

SAUKIA RUSTICA, new species

Text figures 18-20

The cranium of this species is much like that of *Saukia lodensis* (pl. 65). It differs in its proportionally larger palpebral lobes, narrower glabella, and exterior surface of the test. The test of *S. lodensis* is covered with rather large, rounded pustules, and that of *S. rustica* with fine inosculating, irregular ridges that give it a roughened but not a pustulose appearance. The largest cranium has a length of 7 mm. Small specimens 2 to 6 mm. in length show a narrowing of the glabella toward the rounded front.

The associated pygidium has a smaller axial lobe than that of *S. lodensis*.



SAUKIA RUSTICA, new species

FIGS. 18, 18a. ($\times 4$.) Type specimen of cranium and side outline. U. S. National Museum, Catalogue No. 60678.

FIGS. 19, 19a. ($\times 2$.) Pygidium associated with fig. 18. U. S. National Museum, Catalogue No. 60679.

FIG. 20. ($\times 6$.) Small cranium. U. S. National Museum, Catalogue No. 60680.

The associated pygidium is much like that of *Saukia fallax* (pl. 67, fig. 21), and the cranium is of the same general character.

Eoorthis wichitaensis Walcott and *Illanurus* sp. undt. are associated with *S. rustica*.

Formation and locality.—Upper Cambrian: (12j: 50 feet below 12g) Arbuckle limestone (lower part); Wichita Mountains, south side about 8 miles (12.8 km.) west of Fort Sill and in a small hill 2 miles (3.2 km.) southwest of Signal Mountain, Comanche County, Oklahoma. Fossil horizon No. 5 of E. O. Ulrich, 50 feet from base of hill. Collected October 9, 1901.

SAUKIA STOSEI, new species

Plate 69, figs. 3-5; pl. 70, figs. 12, 12a

Dikelocephalus hartti STOSE (on authority of Walcott), 1909, U. S. Geol. Survey Geol. Atlas, U. S., Folio No. 170, p. 6. (Name mentioned in list of fossils from Conococheague limestone.)

Dikelocephalus sp. undt. STOSE (on authority of Walcott), 1909, idem, p. 6. (Mentioned with preceding species.)

This species belongs to the *S. pepinensis* form of *Saukia*, and is most nearly related to *Saukia fallax* (pl. 67, figs. 21, 21a), but it has a proportionately larger palpebral lobe. The associated pygidium (fig. 5, pl. 69) differs from the pygidium found with *S. fallax* in Texas in having a longer axial lobe, and the surface is strongly granulated instead of being smooth as in *S. fallax*.

The specific name is given in recognition of the fine work of Mr. George W. Stose, of the United States Geological Survey.

Formation and locality.—Lower Ozarkian (Ulrich): (59n and 59o) Conococheague limestone, about 800 feet (240 m.) above the base, that is, near the middle, of the formation in a quarry on point of spur northwest of Scotland Station, Franklin County, Pennsylvania (E. O. Ulrich; G. W. Stose, 1901). U. S. Geol. Survey Atlas, folio No. 170.

SAUKIA WARDI, new species

Plate 69, figs. 1, 2

This species is represented by numerous casts of compressed, broken specimens that occur in a yellowish-colored shaly rock. The cranidium has the general character of that of *S. leucosia* (pl. 67, figs. 14, 16) and *S. pepinensis* (pl. 67, figs. 1, 4, 5), but it differs in being proportionately shorter. The frontal limb was gently rounded as in *S. leucosia* and not flattened as in *S. pepinensis*.

The free cheeks are rather broad. Thoracic segments of the type of those of *Saukia lodensis*, and the pygidium of the two species is somewhat similar except that of *S. wardi* is longer in proportion to its width. In this respect it has the outline of the pygidium of *S. pepinensis*, but not the narrow border of the latter. Surface not preserved.

The type specimens are in the Peabody Museum, Yale University, New Haven, Connecticut, and plastotypes in the U. S. National Museum, Nos. 58671 and 58672.

The species is named after Dr. Freeman Ward of Yale University, and I am indebted to Dr. Charles Schuchert for the opportunity to study and name the species.

Formation and locality.—Upper Cambrian: (346f) Beneath the Natural Bridge limestone; soft, shaly-yellow rock, probably a decomposed thin-bedded dolomitic limestone, east side of road about 1.5 miles (2.4 km.) north-northeast of Natural Bridge, south end of Rockbridge County, Virginia (Dr. Freeman Ward of Yale University, 1911).

Genus **OSCEOLIA**, new genus

This genus is known only by the cranidium, associated free cheeks and pygidium of the type species. These parts occur together in the same layer of sandstone to such an extent that it seems reasonable to consider them as belonging to the species *Osceolia osceola* (pl. 68, figs. 4-10). The strong concave frontal limb, broadly conical glabella, and long palpebral lobe serve to distinguish the cranidium from that of *Dikelocephalus* (pls. 60-63), *Saukia* (pls. 65, 66) and *Calvinella* (pl. 70).

The pygidium is characterized by the very strong extension of the anterior segment (pl. 68, figs. 8-10), and in being shorter and more transverse than the pygidium of the three genera mentioned above.

All of the specimens of the typical species *O. osceola* occur in a rather friable sandstone so that little is known of the surface characters. As far as known the genus may be briefly characterized as follows:

Cephalon transversely semicircular with a broad convex frontal limb; genal angles extended into postero-lateral spines.

Glabella obtusely conical, with sides converging slightly to the rounded front. Occipital segment rounded and defined by a narrow, strong furrow from base of glabella. Posterior glabellar furrow strong and extending across the glabella.

Fixed cheeks very narrow; palpebral lobes elongate and extending back of the line of the occipital furrow. Facial suture back of the palpebral lobes extending almost directly outward well towards the genal spine so as to outline a very narrow postero-lateral limb; curving around the palpebral lobes they extend forward with a slight outward curve nearly across the frontal limb and then curve gently inward to the front margin. Free cheeks large.

Associated pygidium nearly twice as broad as long, with strong median axis.

Genotype.—*Dikelocephalus osceola* Hall (1863).

Osceolia is represented by a single species that is readily distinguished by its strong, concave frontal limb, large palpebral lobes, narrow fixed cheeks and transverse pygidium with the great spinous extension of the pleurae of the first segment.

OSCEOLIA OSCEOLA (Hall)

Plate 68, figs. 4-10

Dikelocephalus osceola HALL, 1863, Sixteenth Ann. Rept., New York State Cab. Nat. Hist., p. 146, pl. 10, fig. 18; pl. 7, fig. 49. (Describes and illustrates cranidium and supposed free cheek and pygidium of this species.)

Dikelocephalus osceola HALL, 1867, Trans. Albany Inst., Vol. 5, p. 128, pl. 5, fig. 18; pl. 7, fig. 49 ?. (Reprint of paper of 1863.)

Dicelloccephalus osceola Hall, WALCOTT, 1884, Monogr. U. S. Geol. Survey, No. 8, p. 40, pl. 9, fig. 25. (Identifies cranidium from Nevada and gives illustration. By error the field label was copied in description and the species referred to the Prospect Mountain limestone.)

Conocephalina osceola (Hall), BRÖGGER, 1886, Geol. Fören. i Stockholm Förhandl., Vol. 8, No. 101, p. 205. (Refers species to genus *Conocephalina*.)

The description given under the genus includes what is known of the species. It occurs in the friable St. Croix sandstone as casts, while in the limestones of Nevada and Texas the test is more or less well preserved. The outer surface of the test is nearly smooth, although there are slight indications that it may be minutely punctate.

The largest specimen of the cranidium has a length of 20 mm.

The original illustrations by Hall included a free cheek (1863, pl. 10, fig. 19) that is not the same as the cheek attached to the cranidium (this paper, pl. 68, fig. 7). The pygidium tentatively referred to the species by Hall (1863, pl. 7, fig. 49) probably belongs with it as a similar pygidium occurs with the cranidium in numbers when the only other cranidia are those of *Illænurus quadratus* Hall.

Formation and locality.—Upper Cambrian: St. Lawrence formation; (78) quarry near St. Croix River, in suburbs of Osceola, Polk County (L. C. Wooster, 1883); (83¹) upper horizon near Trempealeau, Trempealeau County (Chas. Schuchert, 1893); and doubtfully (81b) Jordan formation, near Devils Lake, Sauk County (Cooper Curtice, 1884), all in Wisconsin.

Upper Cambrian: (66) Dunderberg shale on the first ridge north of the Dunderberg mine, Eureka district, Eureka County, Nevada (C. D. Walcott, 1880).

Upper Cambrian: (70a) Wilberns formation, Baldy Mountain, near Morgans Creek, 8 miles (12.8 km.) northwest of Burnet, Burnet County, Texas (C. D. Walcott, 1884).

Genus CONOKEPHALINA Brögger

Conocephalina BRÖGGER, 1886, Geol. Fören. i Stockholm Förhandl., No. 101, Vol. 8, pt. 3, p. 206. (Names subgenus to include *Conocephalites ornatus* Brögger, 1877, *Dikelöcephalus osceola* Hall, *D. misa* Hall, *D. spiniger* Hall, but does not define subgenus.)

Conocephalina Brögger, GRÖNWALL, 1902, Danmarks Geol. Unders. Række 2, No. 13, p. 150. (Uses generic name, but does not define genus.)

Conocephalina Brögger, LORENZ, 1906, Zeitschr. deutsch. geol. Gesellsch., Bd. 58, Pt. 2, p. 64. (Revives genus *Conocephalites*, places *Conocephalina* Brögger in it, and takes a new type for *Conocephalina*, in *Conocephalites emmrichi* Barrande.)

Conocephalina Brögger, WALCOTT, 1913, Research in China, Carnegie Inst. Washington, 1913, Vol. 3, The Cambrian Faunas of China, p. 137, pl. 13. (Discussed as below.)

Genotype.—*Conocephalites ornatus* Brögger, 1877, Nyt Mag. Naturvid., Vol. 24, p. 37, pl. 3, fig. 5 (this paper, pl. 64, fig. 8, p. 400).

This genus as pointed out by Brögger occupies an intermediate position between forms referred to *Dikelocephalus* and *Ptychoparia* (*Conocephalites* as used by Brögger). He refers to *Conocephalina*, *Dikelocephalus osceola* Hall, *D. misa* Hall and *D. spiniger* Hall.

In the present paper, *D. misa* is placed under *Conocephalina*, *D. osceola* is made the type of a new genus *Osceolia*, and *D. spiniger* the type of the new genus *Calvinella*.

Conocephalina ornata is illustrated on plate 64, figure 6, in order that it may be compared with *C. misa*, plate 68, figures 1 and 2. In my report on the Cambrian faunas of China¹ a number of species have been referred to *Conocephalina* and an illustration given of *Conocephalites emmrichi* Barrande (pl. 13, fig. 7), a form that may be closely related to *Conocephalina*. If this is correct, *C. misa* cannot be related to *Conocephalina*. We must wait for the discovery of entire specimens of *C. misa* and *C. ornata* before deciding to which family they may belong.

CONOKEPHALINA MISA (Hall)

Plate 68, figs. 1-3

Dikelocephalus misa HALL, 1863, Sixteenth Ann. Rept. New York State Cab. of Nat. Hist., 1863, p. 144, pl. 8, fig. 15; pl. 10, figs. 4, 5 (6, 7, 8?). (Describes and illustrates species.)

Dikelocephalus misa HALL, 1867, Trans. Albany Inst., Vol. 5, p. 126, pl. 3, fig. 15; pl. 5, figs. 4, 5 (6, 7, 8?). (Reprint of paper of 1863.)

Conocephalina misa (Hall), BRÖGGER, 1886, Geol. Fören. i Stockholm Förhandl., Vol. 8, No. 101, p. 205. (Refers species to *Conocephalina*.)

Dicelloccephalus misa Hall, BERKEY, 1898, American Geol., Vol. 21, p. 290, pl. 20, figs. 12, 13. (Not *C. misa*.)

¹ Research in China, Vol. 3, Carnegie Institution of Washington, Pub. No. 54, 1913, The Cambrian Faunas of China pl. 13.

The species is known only by the cranidium and fragments of associated pygidium that may belong to it. The cranidium differs from that of *Saukia lodensis* (pl. 65) in having a narrowing of the glabella from base to front and in its frontal limb and rim. With the specimens available for study the impression is that we may be dealing with a form more closely allied to *Conocephalina* Brögger than to *Saukia*. It differs from *Conocephalina* in the apparent direction of the facial sutures through the frontal rim of the cephalon; the form of the frontal limb and rim also differ in detail from those of *Conocephalina*. If the associated pygidium (fig. 3) belongs with the cranidia (figs. 1, 2) the provisional reference of the species to the Dikelocephalinae is probably correct.

The largest cranidium in the collection has a length of 21 mm.

Formation and locality.—Upper Cambrian: Franconia formation; Green-sand horizon; (83^a) below the "fifth trilobite bed" of Owen, at Trempealeau, Trempealeau County (Chas. Schuchert, 1893), and (83^b) Bluff Siding, Buffalo County (Collection of W. A. Finkelnburg, Winona, Minnesota), both in Wisconsin.

(99) Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona Counties, Minnesota (Cooper Curtice, 1884).

Genus CALVINELLA, new genus

Calvinella is founded on the cranidium of *Dikelocephalus spiniger* Hall and associated free cheeks, thoracic segments, and pygidium.

The cranidium (pl. 68, figs. 11, 13, 15) has the same general form as that of *Saukia leucosia* (pl. 67, figs. 14, 16) and, in addition, a strong occipital spine. The associated pygidium (pl. 68, figs. 18, 19) differs from the *Saukia leucosia* group of species (pl. 67, figs. 3, 12, 13, 17, 20) in having a broad flattened border comparable with that of the pygidium of *Dikelocephalus* (pl. 60, figs. 6, 7; pl. 63, fig. 6), but the cranidium of *Calvinella* is quite unlike that of *Dikelocephalus*. Further comparisons and remarks are given under observations on the family Dikelocephalinae (p. 362).

Calvinella has a marked resemblance to some species referred to *Anomocare* from the Middle Cambrian. The type species of *Anomocare*, *A. laeve* Angelin¹ has nearly the same form of glabella and palpebral lobes, but the frontal limb is dissimilar. The pygidium is essentially of the same character in the two genera.

The outer surface of all of the species of the genus is strongly granulose on the glabella, free cheeks, parts of the thoracic segments

¹ Research in China, Vol. 3, Carnegie Institution of Washington, Pub. No. 54, 1913, The Cambrian Faunas of China, p. 264, pl. 18, figs. 1, 1b.

and pygidium. This is finely shown by figures 1, 8, and 9, plate 70, and less distinctly by the casts of *C. spiniger* (pl. 68, figs. 11, 13, and 20).

A small cranidium occurs in a coarse sandstone near Devils Lake, Sauk County, Wisconsin (81b), that suggests by its large palpebral lobe, rounded frontal rim and strong posterior glabellar furrow, a form of *Calvinella* that differs from *C. spiniger* by having the glabella narrow gradually towards its rounded front. The specimen is a cast and it is too imperfect for specific identification.

Genotype.—*Dikelocephalus spiniger* Hall (1863) (this paper, p. 390).

Stratigraphic range.—Upper beds of Upper Cambrian and lower beds of the Ozarkian of Ulrich.

Geographic distribution.—Upper Mississippi valley in Missouri (*C. ozarkensis*) and Wisconsin (*C. spiniger*); Atlantic Basin region of New Jersey (*C. newtonensis*); Cordilleran region (*C. tenuisculpta*).

CALVINELLA NEWTONENSIS (Weller)

Plate 70, figs. 7-11, 11a

Dikelocephalus newtonensis WELLER, 1903, Geol. Surv. New Jersey, Rept. on Pal., Vol. 3, pp. 121-122, pl. 3, figs. 1-7. (Description and illustration.)

Specimens from the type locality now in the U. S. National Museum Collections show that this species has a well-marked occipital spine similar to that on specimens of *C. ozarkensis* from Missouri that appear to be almost identical with *C. newtonensis*. The former differs in having a more broadly rounded frontal rim, a more transverse frontal margin to the glabella and a larger occipital spine.

The specimens illustrated by Weller in the New Jersey Report are small and do not show the characters of the cranidium so fully as the large specimens in the National Museum Collections. Photographs of the type (fig. 7) and cotype (fig. 6) are given on plate 60, also an associated cranidium (fig. 8), free cheek (fig. 9), and pygidium (figs. 10, 10a).

Formation and locality.—Lower Ozarkian: (11c)¹ Lower part of Kittatinny limestone, O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey (H. E. Dickhaut, 1901).

CALVINELLA OZARKENSIS, new species

Plate 70, figs. 1-6

This fine species is represented by the cranidium, free cheeks, and an associated pygidium. The cranidium is much like that of *Calvin-*

¹By error locality 11c has "Hardyston Quartzite" for Kittatinny limestone in Monograph 51, U. S. Geol. Survey, 1912, pp. 178, 466, 539 and 784.

ella newtonensis (pl. 70, fig. 8). It differs most in the form of the frontal border. The associated pygidia differ in the form of the axial lobe (Compare figs. 2, 5 and 10).

The large cranidium (fig. 1, pl. 70) is from a locality 4 miles (6.4 km.) west of the town of Eminence, and the pygidium (fig. 2) from about a mile (1.6 km.) east of the town. They occur at about the same stratigraphic horizon and with the same fauna. Other fragments of cranidia and pygidia referred to this species occur in association at each locality.

The small cranidium (fig. 4) and associated pygidium (fig. 5) are probably from a young specimen, although they occur about 75 to 100 feet (22.8 m. to 30.4 m.) higher in the strata.

Dr. E. O. Ulrich collected the specimens in association with a strongly marked fauna that he refers to his Ozarkian group of formations. The fauna is mentioned in the introduction of this paper, p. 359.

Formation and locality.—Lower or Middle Ozarkian: Eminence formation; (102f) middle part of formation, 1 to 1.5 miles (1.6 to 2.4 km.) east of town of Eminence; also from (100b) same horizon as 102f and near it at the Slater mine; also (102h), 4 miles (6.4 km.) west of Eminence; all in Shannon County; and locality 188y, upper part of Eminence formation near town of Flat River, St. Francis County, all in Missouri.

The locality numbers cited above are those of Dr. E. O. Ulrich and are recorded in catalogues of the United States Geological Survey.

CALVINELLA SPINIGER (Hall)

Plate 68, figs. 11-23a

Dikelocephalus spiniger HALL, 1863, Sixteenth Ann. Rept., State Cab. Nat. Hist., p. 143, pl. 10, figs. 1, 2, 3?. (Detailed description with illustration of cranidium and pygidium.)

Dikelocephalus spiniger HALL, 1867, Trans. Albany Inst., Vol. 5, p. 124, pl. 5, figs. 1, 2, 3?. (Reprint of paper of 1863.)

Conocephalina spiniger (Hall), BRÖGGER, 1886, Geol. Fören. i Stockholm Förhandl., Vol. 8, No. 101, pp. 205, 206. (Refers *D. spiniger* to proposed new genus *Conocephalina*.)

The description by Hall (1863) is detailed, and there is little new to add to it that is not shown by the figures on plate 68. All of our specimens are casts in a fine-grained, rather compact sandstone. The outer surface of the test appears to have been slightly roughened by

fine, raised irregular lines that occur on the glabella, fixed cheeks, border of cephalon, thoracic segments, and central parts of the pygidium.

The species is clearly separated by its occipital spine from *Saukia leucosia* (pl. 67, figs. 14, 16), the form nearest to it, and by the associated pygidia (Compare differences in figs. 18, 19, pl. 68, with figs. 17, 17a, pl. 67).

The pygidium recalls some of the pygidia referred to *Anomocare* from the Middle Cambrian of China.¹

Formation and locality.—Upper Cambrian: St. Lawrence formation; (83¹, 83², 135c, and 135d), Trempealeau, Trempealeau County, Wisconsin (Chas. Schuchert, 1893).

Locality 83¹ is above the *Dikelocephalus minnesotensis* zone of 83² (= 135c and 135d).

CALVINELLA TENUISCULPTA, new species

Plate 64, figs. 7, 7a

This species is represented by a single cranidium that in proportions and most details approaches quite closely the cranidium of *Calvinella spiniger* (pl. 68). It differs in having a more convex border and slightly broader fixed cheeks in front of the palpebral lobes.

The test appears to be minutely punctate and to have obscure, irregularly arranged, fine flat ridges crossing and curving forward on the glabella.

The type specimen of the cranidium has a length of 11 mm.

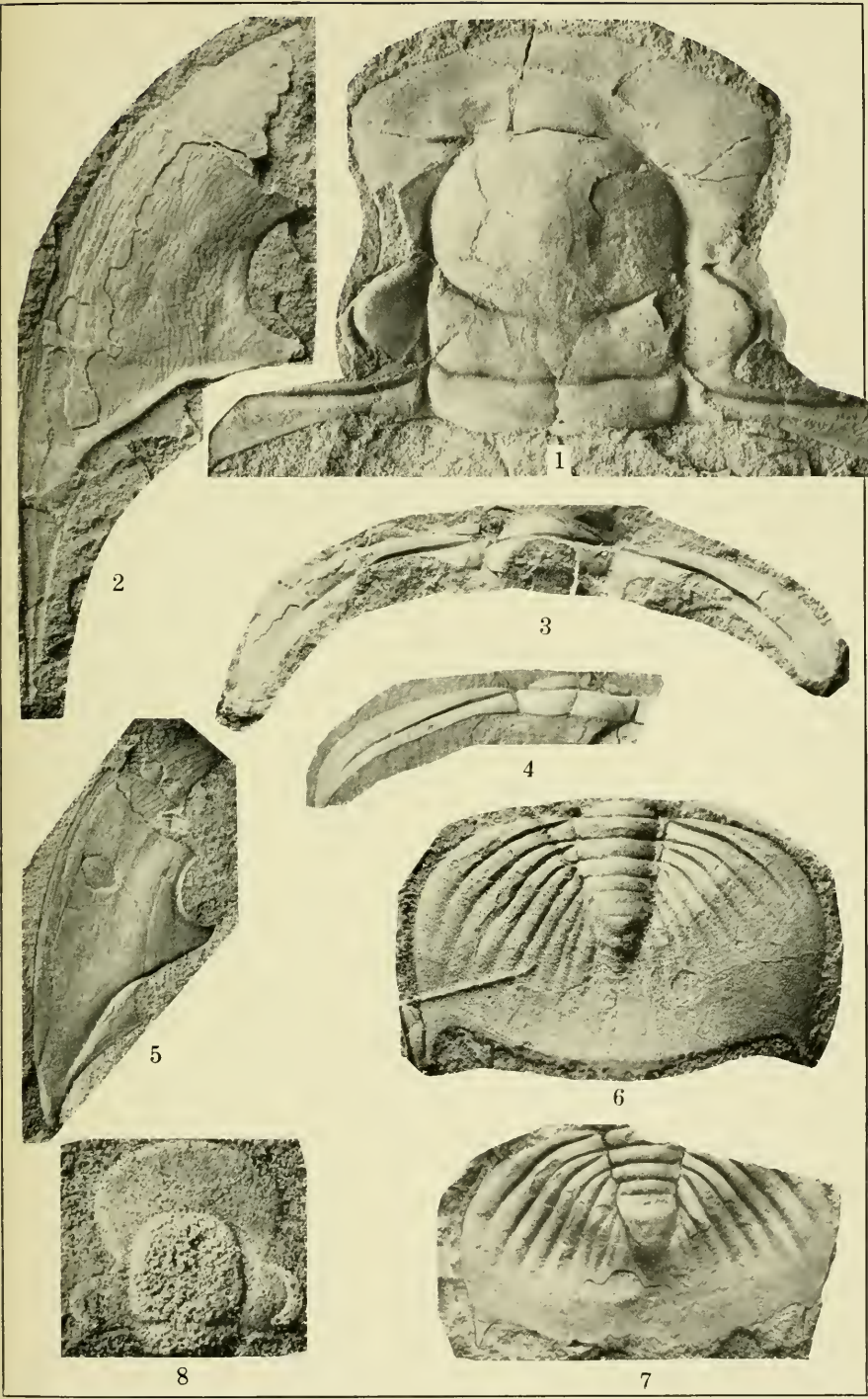
Formation and locality.—Lower Ordovician (? Ozarkian): (201a) Pogonip limestone; east slope of the ridge east of Hamburg Ridge, Eureka district, Nevada (C. D. Walcott, 1882).

¹ Research in China, Vol. 3, Carnegie Institution of Washington, Pub. No. 54, 1913, The Cambrian Faunas of China, pl. 18, figs. 1b, 4c.

² *Dikelocephalus*, species undetermined. Fragments of a large species of *Dikelocephalus* occur in collections from the Gallatin limestone on the west side of the Bridger Range, Gallatin County, Montana (locality 151, Upper Cambrian). The glabella of the cranidium is similar to that of *D. minnesotensis* and the associated pygidium appears to be similar to that of *D. ? limbatus*. (This note was added after the present paper was in page proof.)

DESCRIPTION OF PLATE 60

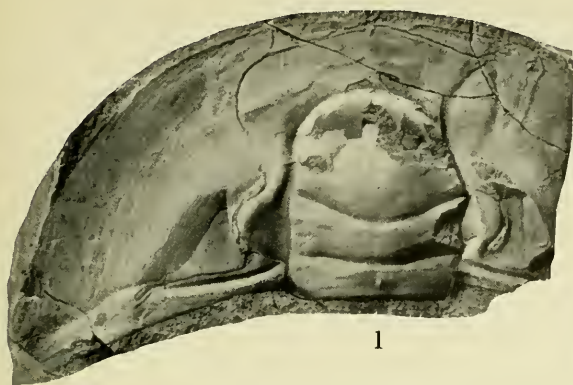
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| <i>Dikelocephalus minnesotensis</i> Owen. (See pls. 61, 62, and 66)..... | 369 |
| FIG. 1. (Natural size.) Cranium flattened in shaly sandstone. (85.)
U. S. National Museum, Catalogue No. 58594. | |
| 2. (Natural size.) Impression of outer surface of free cheek.
(113.) U. S. National Museum, Catalogue No. 58595. | |
| 3. (One-half natural size.) Thoracic segment flattened in shaly
sandstone. (85.) U. S. National Museum, Catalogue
No. 58596. | |
| 4. (One-half natural size.) Segment from shaly sandstone. From
locality 85x, Upper Cambrian: St. Lawrence formation
near Mazomanie, Dane County, Wisconsin. U. S. National
Museum, Catalogue No. 58597. | |
| 5. (One-half natural size.) Free cheek in shaly sandstone. (85.)
U. S. National Museum, Catalogue No. 58598. | |
| The specimens represented by figs. 1, 3, and 5 are from locality
85, Upper Cambrian: St. Lawrence formation at Prairie du Sac,
Sauk County, Wisconsin. | |
| 6. (Natural size.) Pygidium flattened in shaly sandstone. (113.)
U. S. National Museum, Catalogue No. 58599. | |
| The specimens represented by figs. 2 and 6 are from locality 113,
Upper Cambrian: St. Lawrence formation at La Grange Mountain
(or Barn Bluff), near Red Wing, Goodhue County, Minnesota. | |
| 7. (One-half natural size.) Pygidium preserving considerable of
its natural convexity. From locality 86, Upper Cambrian:
St. Lawrence formation at Van Ness quarry, Gibraltar
Bluff, Lodi, Columbia County, Wisconsin. U. S. National
Museum, Catalogue No. 58600. | |
| 8. (× 3.) Cephalon of young individual with very broad frontal
lmb. From locality 83 ² , Upper Cambrian: An upper
horizon of the St. Lawrence formation near Trempealeau,
Trempealeau County, Wisconsin. U. S. National Museum,
Catalogue No. 58601. | |



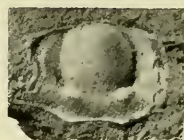
DIKELOCEPHALUS MINNESOTENSIS Owen

DESCRIPTION OF PLATE 61

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| <i>Dikelocephalus minnesotensis</i> Owen. (See pls. 60, 62, and 66)..... | 369 |
| FIG. 1. (One-half natural size.) Large cephalon flattened in shaly sandstone. (85.) U. S. National Museum, Catalogue No. 58602. | |
| 2. (Natural size.) Cranidium for comparison with fig. 5. (85.) U. S. National Museum, Catalogue No. 58603. | |
| The specimens represented by figs. 1 and 2 are from locality 85, Upper Cambrian: St. Lawrence formation at Prairie du Sac, Sauk County, Wisconsin. | |
| 3. (Natural size.) Hypostoma associated with this species in locality 83 ¹ , Upper Cambrian: Uppermost horizon of the St. Lawrence formation near Trempealeau, Trempealeau County, Wisconsin. U. S. National Museum, Catalogue No. 58604. | |
| 5 and 5a. (Natural size.) Dorsal and side views of a cranidium preserving most of its natural convexity. (113.) U. S. National Museum, Catalogue No. 58606. | |
| The specimens represented by figs. 4 (below) and 5 are from locality 113, Upper Cambrian: St. Lawrence formation at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota. | |
| 6 and 6a. (Natural size.) Top and side views of a pygidium preserving its natural convexity. From locality (3747 U. S. N. M. records) Stillwater, Minnesota. U. S. National Museum, Catalogue No. 3747. | |
| 7. (One-half natural size.) Doublure of under side of cephalon with hypostoma in place. From locality 85x, Upper Cambrian: Upper beds of the St. Lawrence formation near Mazomanie, Dane County, Wisconsin. U. S. National Museum, Catalogue No. 58607. | |
| <i>Dikelocephalus minnesotensis</i> var. | 371 |
| FIG. 4. (Natural size.) Small pygidium with strong spines. (113.) U. S. National Museum, Catalogue No. 58605. | |
| <i>Saukia crassimarginata</i> (Whitfield). (See pls. 65 and 66)..... | 377 |
| FIG. 8. (Natural size.) Matrix of cranidium. This is illustrated by Owen, 1852, pl. 1, fig. 10, as <i>D. (minnesotensis ?)</i> , locality La Grange Mountain, Minnesota (= 113). Upper Cambrian: St. Lawrence formation at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota. U. S. National Museum, Catalogue No. 58628. | |



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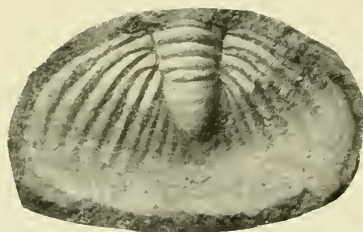
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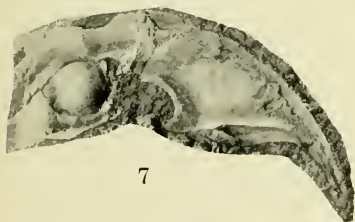
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5a



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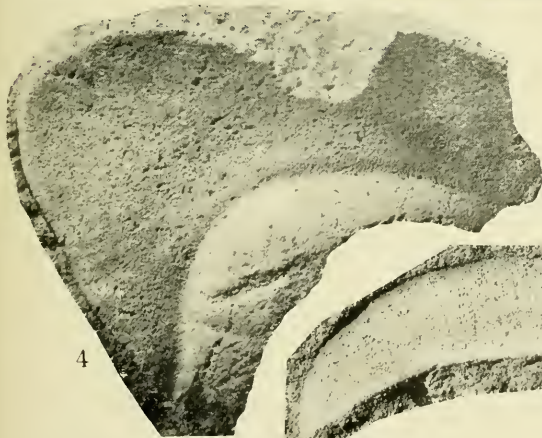
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DESCRIPTION OF PLATE 62

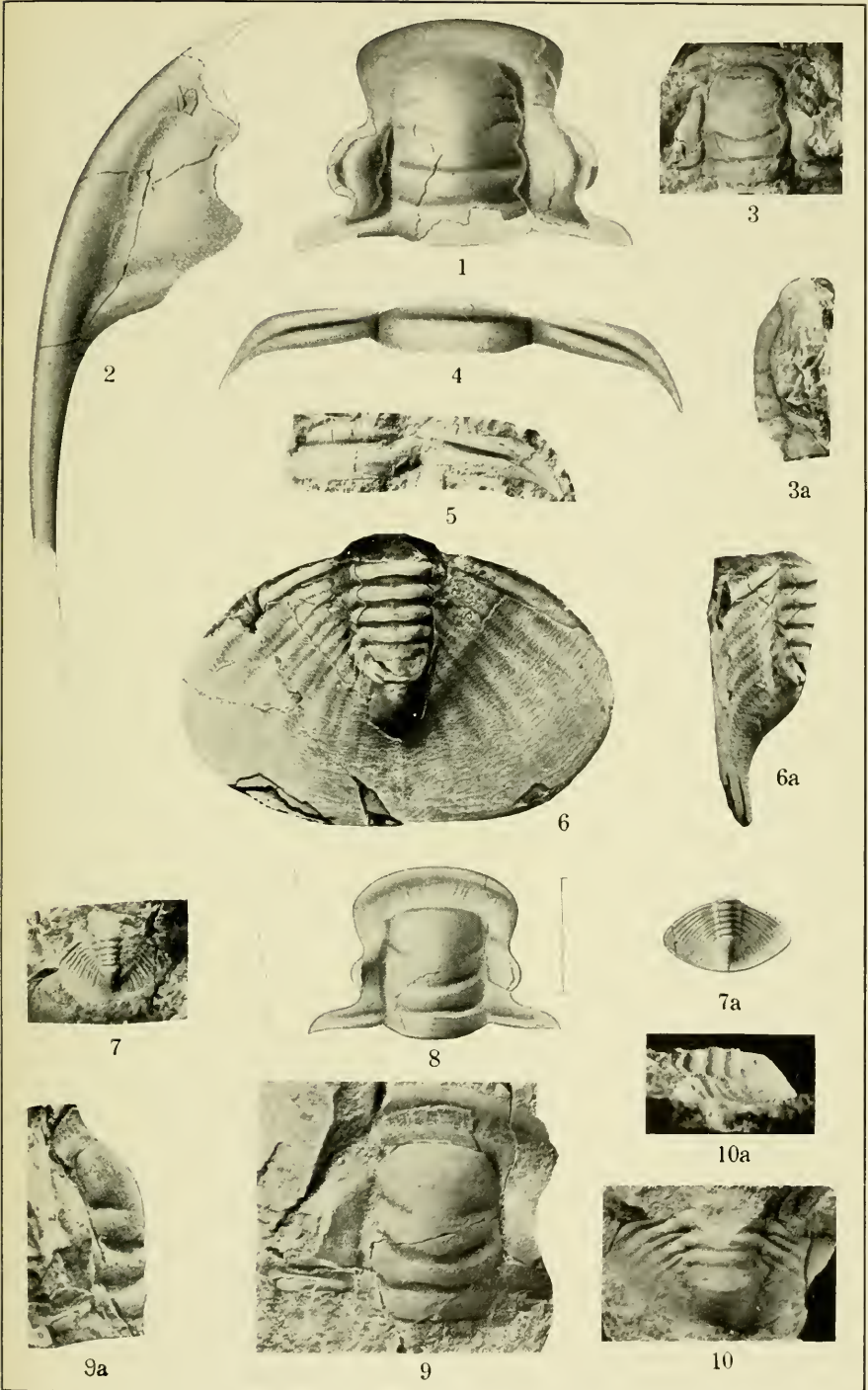
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- Dikelocephalus vanhorni* Walcott..... 373
- FIG. 1. (Natural size.) Type specimen of cranidium.
 2. (Natural size.) Thoracic segment associated with this species.
 3. (Natural size.) Pygidium associated with the cranidium represented by fig. 1.
- The three specimens represented by figs. 1-3 are from the Upper Cambrian: St. Lawrence formation, (346d) Hoka, Houston County, Minnesota. They are lot No. 14393, Walker Museum, University of Chicago. Plastotype U. S. National Museum, Catalogue No. 58608, *a, b, c.*
- Dikelocephalus minnesotensis* Owen ?? (See pls. 60, 61, 66)..... 369
- FIG. 4. (Natural size.) Fragment of cranidium. From locality 78b, Upper Cambrian: St. Lawrence formation, 50 feet (15.2 m.) above the St. Croix River, near the landing at Osceola, Polk County, Wisconsin. U. S. National Museum, Catalogue No. 58609.
5. (Natural size.) Hypostoma from about the same horizon as fig. 4. (78.) U. S. National Museum, Catalogue No. 58610.
 6. (Natural size.) Fragment of thoracic segment associated with fig. 5. (78.) U. S. National Museum, Catalogue No. 58611.
- The specimens represented by figs. 5 and 6 are from locality 78, Upper Cambrian: St. Lawrence formation; quarry near St Croix River, in suburbs of Osceola, Polk County, Wisconsin.



DIKELOCEPHALINÆ

DESCRIPTION OF PLATE 63

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<i>Dikelocephalus hartti</i> (Walcott).....	368
FIG. 1. (Natural size.) Wash drawing of a large cranidium. U. S. National Museum, Catalogue No. 58571.	
2. (Natural size.) Wash drawing of free cheek associated with fig. 1. U. S. National Museum, Catalogue No. 58572.	
3. (Natural size.) Dorsal view of a small cranidium, showing the proportional decrease in width of the frontal rim as compared with fig. 1. U. S. National Museum, Catalogue No. 58573.	
4. (Natural size.) Wash drawing of partly restored thoracic segment, of which fig. 5 is a photographic reproduction of the specimen.	
5. (Natural size.) Portion of thoracic segment. U. S. National Museum, Catalogue No. 58575.	
6 and 6a. (Natural size.) Dorsal and side views of a large pygidium, illustrating the increase in width of the border as compared with the specimen represented by fig. 8. U. S. National Museum, Catalogue No. 58576.	
7 and 7a. (Natural size.) Photographic reproduction and wash drawing of a small pygidium. U. S. National Museum, Catalogue No. 58577.	
 <i>Dikelocephalus ? tribulis</i> Walcott.....	 372
FIG. 8. (× 1.5.) Wash drawing of the specimen represented by fig. 9.	
9 and 9a. (× 2.) Dorsal and side views of the type specimen of the cranidium of the species. U. S. National Museum, Catalogue No. 58578.	
10 and 10a. (× 2.) Dorsal and side views of pygidium tentatively referred to this species. U. S. National Museum, Catalogue No. 58617.	
The specimens represented by figs. 1-10 are from locality 76, Upper Cambrian: Hoyt formation; arenaceous limestone, Hoyts quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, New York.	



DIKELOCEPHALINÆ

DESCRIPTION OF PLATE 64

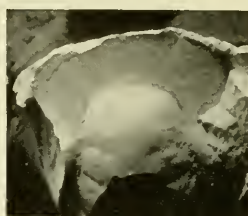
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| <i>Dikelocephalus</i> ? <i>dalyi</i> Walcott..... | 367 |
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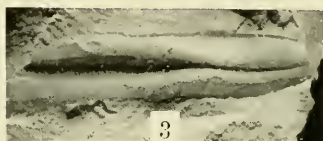
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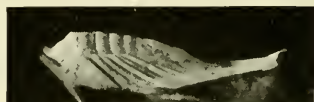
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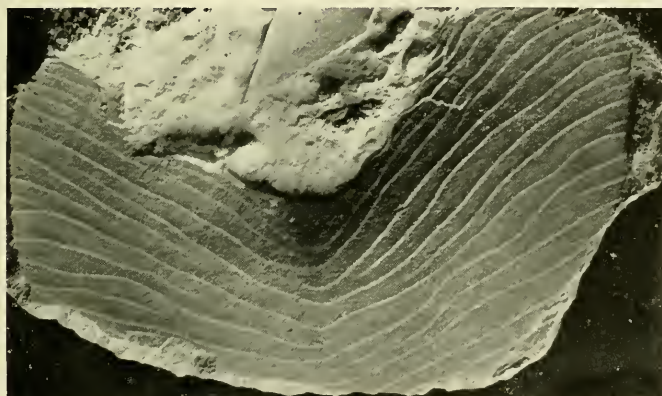
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4a



5



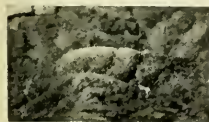
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6a

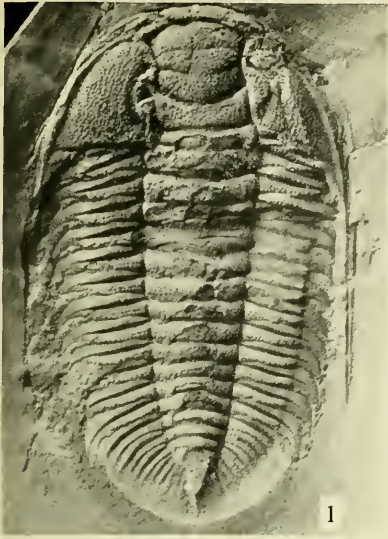


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| FIG. 1. (Natural size.) Entire dorsal shield flattened in shaly sandstone. Plaster cast. U. S. National Museum, Catalogue No. 58618. Original specimen in collection of Edgar E. Teller, Milwaukee, Wis. | |
| 2. (\times 3.) Small cranium with strong tubercles. U. S. National Museum, Catalogue No. 58619. | |
| 3. (Natural size.) Matrix of a dorsal shield flattened in shaly sandstone. Plaster cast. U. S. National Museum, Catalogue No. 58620. Original specimen in collection of Edgar E. Teller, Milwaukee, Wis. | |
| The specimens represented by figs. 1-3 are from locality 85, Upper Cambrian: St. Lawrence formation at Prairie du Sac, Sauk County, Wisconsin. | |
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| 6. (Natural size.) Cranium from a different layer but at about the same horizon in the section. (78.) U. S. National Museum, Catalogue No. 58623. | |
| 7. (Natural size.) Fragmentary pygidium associated with the cranium represented by fig. 6. (78.) U. S. National Museum, Catalogue No. 58624. | |
| The specimens represented by figs. 6 and 7 are from localities 78 and 78b, Upper Cambrian: St. Lawrence formation, quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin. | |
| 8. (\times 2.) Pygidium of the same general type as that of fig. 7. From locality 81b, Upper Cambrian: Jordan ? sandstone, near Devils Lake, Sauk County, Wisconsin. U. S. National Museum, Catalogue No. 58625. | |
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| 10. (Natural size.) Cast of interior surface of pygidium from locality 83 ¹ , Upper Cambrian: An upper horizon of the St. Lawrence formation near Trempealeau, Trempealeau County, Wisconsin. This has the general character of the specimen represented by fig. 9. U. S. National Museum, Catalogue No. 58627. | |



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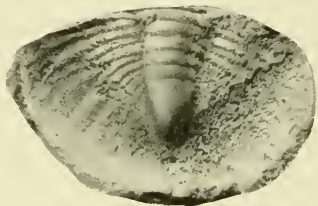
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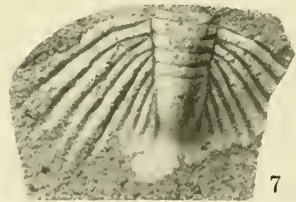
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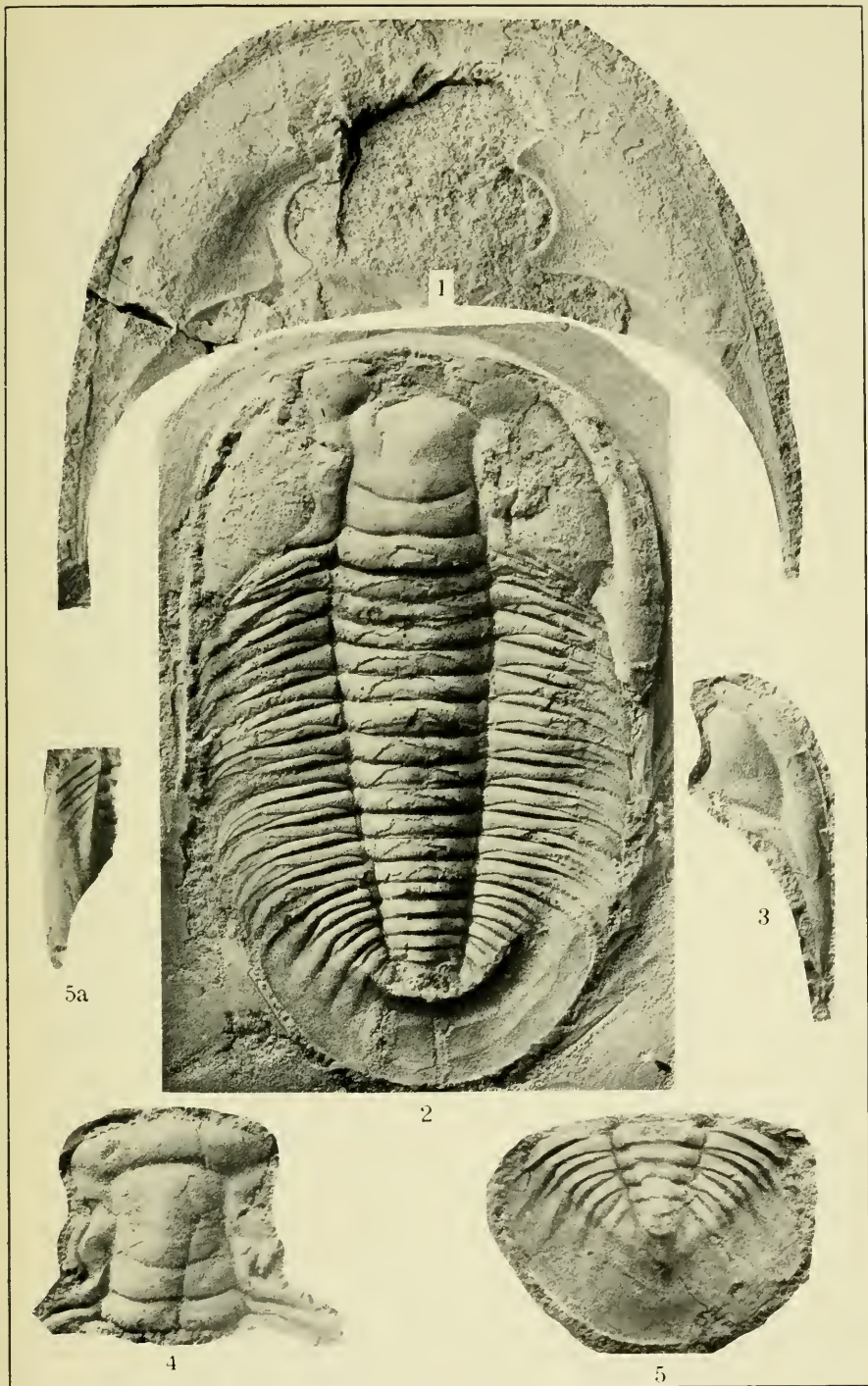


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From locality 113, Upper Cambrian: St. Lawrence formation at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota. Plaster cast. U. S. National Museum, Catalogue No. 58612. Original specimen in collection of Edgar E. Teller, Milwaukee, Wisconsin. | |
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| 3. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58614. | |
| 4. (Natural size.) Cranidium. U. S. National Museum, Catalogue No. 58615. | |
| 5 and 5a. (Natural size.) Top and side views of a slightly flattened pygidium. U. S. National Museum, Catalogue No. 58616. | |
| The specimens represented by figs. 2-5 are from locality 85, Upper Cambrian: St. Lawrence formation at Prairie du Sac, Sauk County, Wisconsin. | |



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FIG. 1. (Natural size.) The type cranidium of Owen from La Grange Mountain, near Red Wing, Minnesota. U. S. National Museum, Catalogue No. 17868.

This specimen is figured by Owen, 1852, pl. 1, fig. 9a.

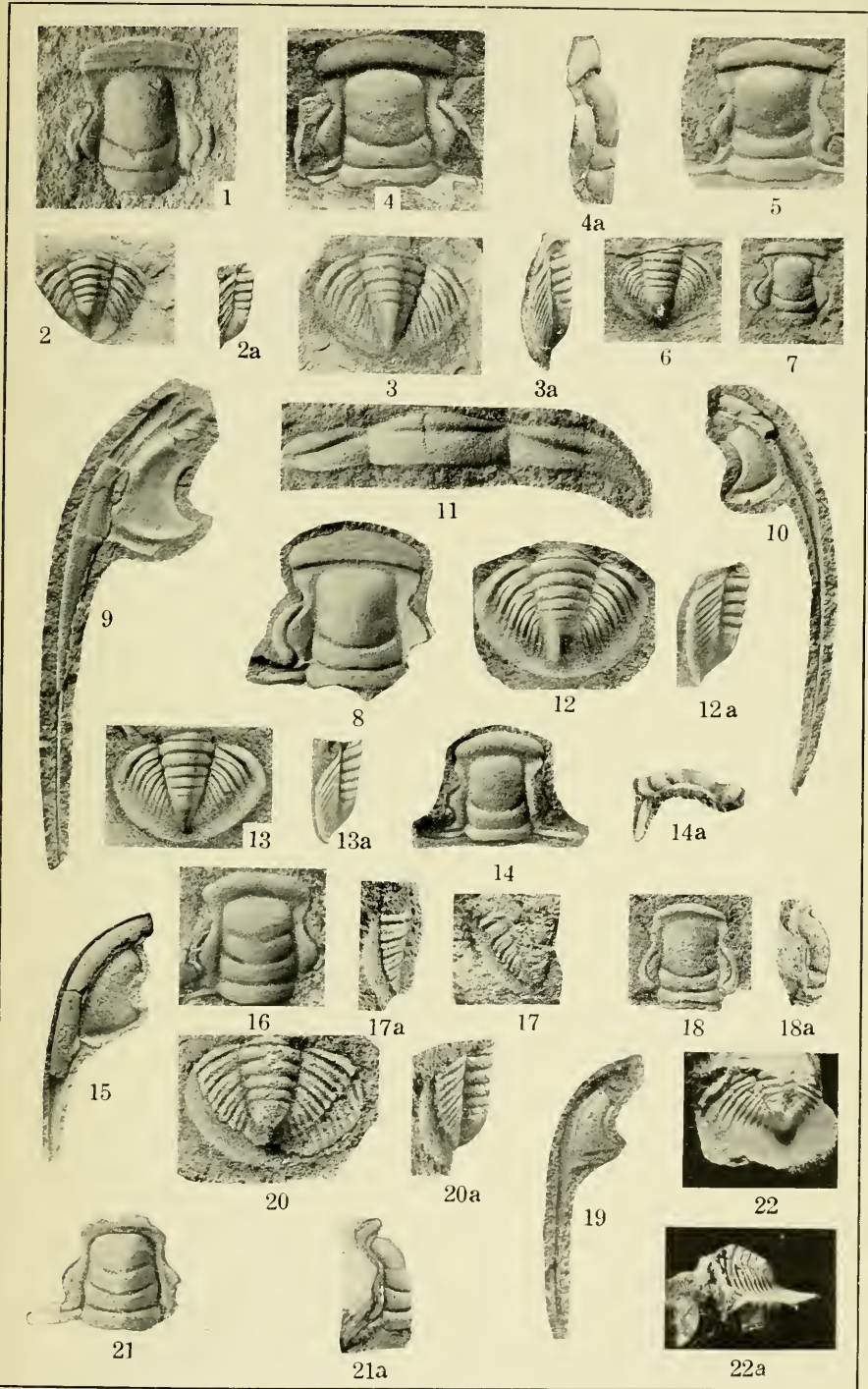
- 2 and 2a. (Natural size.) Dorsal and side views of pygidium from Owen's collection, associated with the cranidium represented by fig. 1. U. S. National Museum, Catalogue No. 58629.
- 3 and 3a. (Natural size.) Dorsal and side views of pygidium illustrated by Owen, 1852, pl. 1, fig. 9b. U. S. National Museum, Catalogue No. 17868.
- 4 and 4a. ($\times 1.5$.) Dorsal and side views of a cranidium that is very slightly compressed. U. S. National Museum, Catalogue No. 58630.
5. (Natural size.) A flattened cranidium, varying slightly in outline of glabella and frontal rim from the type cranidium of the species, fig. 1. U. S. National Museum, Catalogue No. 58631.
6. ($\times 2$.) Small pygidium enlarged for comparison with figs. 2 and 3. U. S. National Museum, Catalogue No. 58632.
7. ($\times 2$.) Small cranidium enlarged for comparison with adults, figs. 1, 4, and 5. U. S. National Museum, Catalogue No. 58633.
8. (Natural size.) A large cranidium showing entire palpebral lobe. U. S. National Museum, Catalogue No. 58634.
9. (Natural size.) Matrix of free cheek with parts of doublure and genal spine. U. S. National Museum, Catalogue No. 58635.
10. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58636.
11. ($\times 2$.) Thoracic segment. U. S. National Museum, Catalogue No. 58637.
- 12, 12a, 13, and 13a. (Natural size.) Dorsal and side views of two unusually perfect pygidia that vary slightly in details from figs. 2 and 3. U. S. National Museum, Catalogue Nos. 58638 and 58639.

The specimens represented by figs. 1-13a are from locality 113, Upper Cambrian: St. Lawrence formation at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota.

Saukia leucosia Walcott 379

FIGS. 14 and 14a. (Natural size.) Dorsal and side views of the type specimen of the cranidium. U. S. National Museum, Catalogue No. 58640.

15. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58641.



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Saukia leucosia Walcott—Continued.

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FIG. 16. ($\times 1.5$.) View of a smaller cranium than that of fig. 14. The photograph is from a wax impression taken from a natural matrix. U. S. National Museum, Catalogue No. 58642.

17 and 17a. ($\times 1.5$.) Dorsal and side views of a fragmentary pygidium associated with the cranidia represented by figs. 14 and 16. U. S. National Museum, Catalogue No. 58643.

The specimens represented by figs. 14-17a are from locality 78, Upper Cambrian: St. Lawrence formation; quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin.

Saukia pyrene Walcott 382

FIGS. 18 and 18a. (Natural size.) Dorsal and side views of type specimen of the cranium. U. S. National Museum, Catalogue No. 58644.

19. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58645.

20 and 20a. ($\times 2$.) Dorsal and side views of pygidium referred to this species. U. S. National Museum, Catalogue No. 58646.

The specimens represented by figs. 18-20 are from locality 78, Upper Cambrian: St. Lawrence formation; quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin.

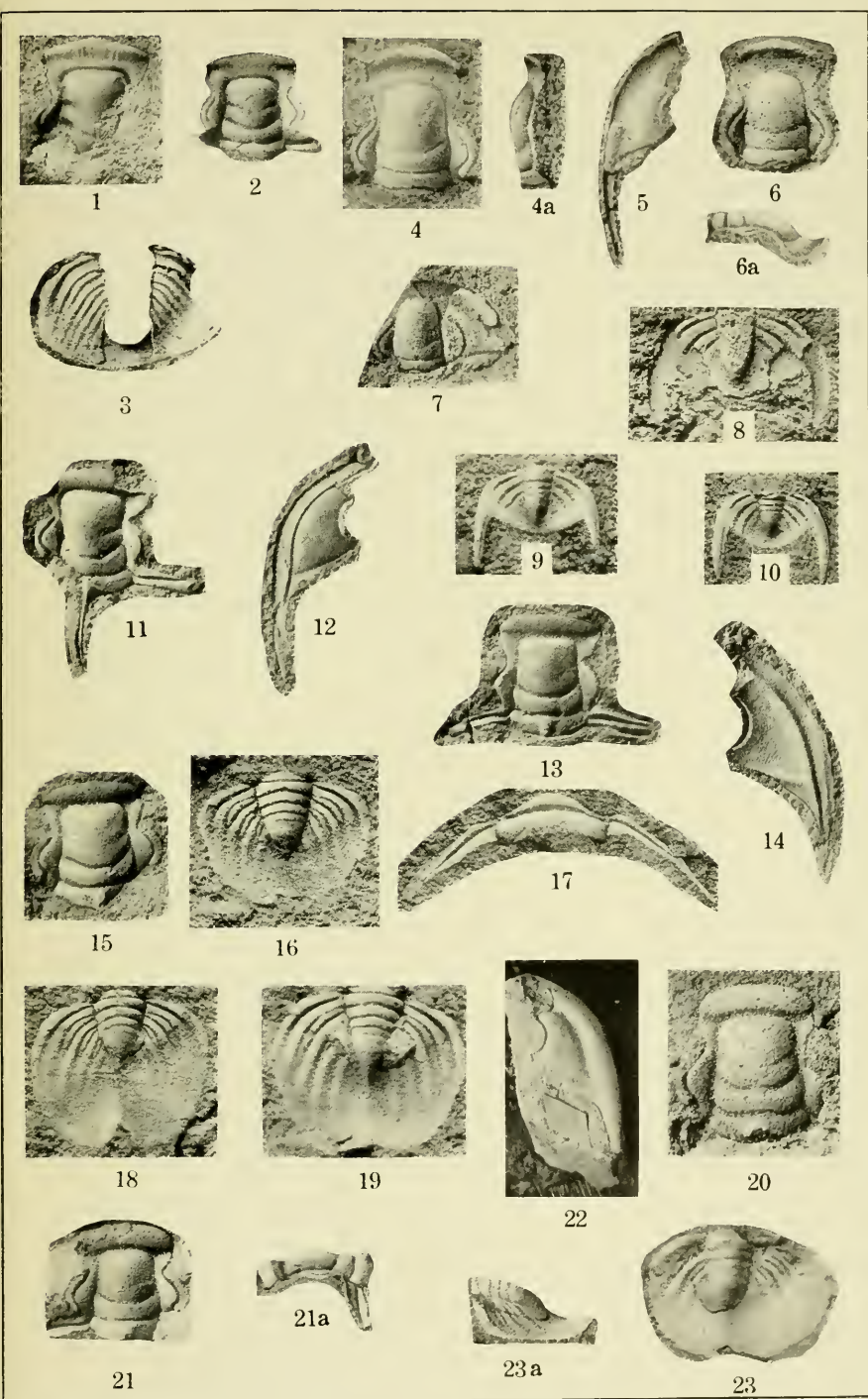
Saukia fallax Walcott 378

FIGS. 21 and 21a. (Natural size.) Dorsal and side views of a cranium from locality 70a, Upper Cambrian: Wilberns formation, Baldy Mountain, near Morgans Creek, Burnet, Burnet County, Texas. U. S. National Museum, Catalogue No. 58647.

22 and 22a. (Natural size.) Dorsal and side views of a pygidium from the same locality (70a) as the specimen represented by figs. 21 and 21a. U. S. National Museum, Catalogue No. 60682.

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| <p>FIG. 1. (Natural size.) Fragment of a cranidium showing frontal limb and margin. U. S. National Museum, Catalogue No. 58661.</p> <p>2. (Natural size.) A cranidium showing general characters of the species. U. S. National Museum, Catalogue No. 58662.</p> <p>3. (Natural size.) Fragmentary pygidium associated with the cranidia represented by figs. 1 and 2. U. S. National Museum, Catalogue No. 58663.</p> <p>The specimens represented by figs. 1-3 are from locality 83³, Upper Cambrian: Green-sand horizon in the Franconia formation below the "fifth trilobite bed" of Owen, at Trempealeau, Trempealeau County, Wisconsin.</p> | |
| <i>Osceolia osceola</i> (Hall) | 386 |
| <p>FIGS. 4 and 4a. (× 1.5.) Dorsal and side views of cranidium. U. S. National Museum, Catalogue No. 58664.</p> <p>5. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58665.</p> <p>6 and 6a. (× 2.) Dorsal and side views of small cranidium. U. S. National Museum, Catalogue No. 58666.</p> <p>7. (Natural size.) Cranidium with right free cheek attached. U. S. National Museum, Catalogue No. 58667.</p> <p>8 and 9. (× 2.) Pygidia associated with cranidia represented by figs. 4 and 6. U. S. National Museum, Catalogue Nos. 58668 and 58669.</p> <p>10. (Natural size.) Pygidium photographed from wax cast of natural matrix. U. S. National Museum, Catalogue No. 58670.</p> <p>The specimens represented by figs. 4-10 are from locality 78, Upper Cambrian: St. Lawrence formation; quarry near St. Croix River, in suburbs of Osceola, Polk County, Wisconsin.</p> | |
| <i>Calvinella spiniger</i> (Hall) | 390 |
| <p>FIG. 11. (Natural size.) Cranidium with slender occipital spine. (83².) U. S. National Museum, Catalogue No. 58648.</p> <p>12. (Natural size.) Free cheek. (83².) U. S. National Museum, Catalogue No. 58649.</p> <p>13. (× 1.25.) Nearly entire cranidium flattened in shaly sandstone. (83².) U. S. National Museum, Catalogue No. 58650.</p> <p>14. (Natural size.) Matrix of free cheek. (83².) U. S. National Museum, Catalogue No. 58651.</p> <p>15. (× 1.25.) Cranidium varying in details from figs. 11 and 13. (83².) U. S. National Museum, Catalogue No. 58652.</p> <p>16. (× 1.25.) Pygidium flattened in shaly sandstone. (135d.) U. S. National Museum, Catalogue No. 58653.</p> | |



Calvinella spiniger (Hall)—Continued.

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FIG. 17. ($\times 1.25$.) Thoracic segment. (135d.) U. S. National Museum, Catalogue No. 58654.

18 and 19. ($\times 1.25$.) Pygidia associated with the cranidia represented by figs. 11, 13, and 15. (83².) U. S. National Museum, Catalogue Nos. 58655 and 58656.

The specimens represented by figs. 11-19 are from localities 83² and 135d, Upper Cambrian: St Lawrence formation; "fifth trilobite bed" of Owen, Trempealeau, Wisconsin.

20. ($\times 2$.) Small cranidium in fine sandstone with strong frontal rim. U. S. National Museum, Catalogue No. 58657.

21 and 21a. (Natural size.) Cranidium preserving its natural convexity. U. S. National Museum, Catalogue No. 58658.

22. (Natural size.) Free cheek. U. S. National Museum, Catalogue No. 58659.

23 and 23a. (Natural size.) Dorsal and side views of a pygidium preserving its natural convexity. U. S. National Museum, Catalogue No. 58660.

The specimens represented by figs. 20-23a are from a fine-grained sandstone of locality 83¹, Upper Cambrian; An upper horizon of the St. Lawrence formation near Trempealeau, Trempealeau County, Wisconsin.

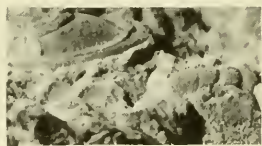
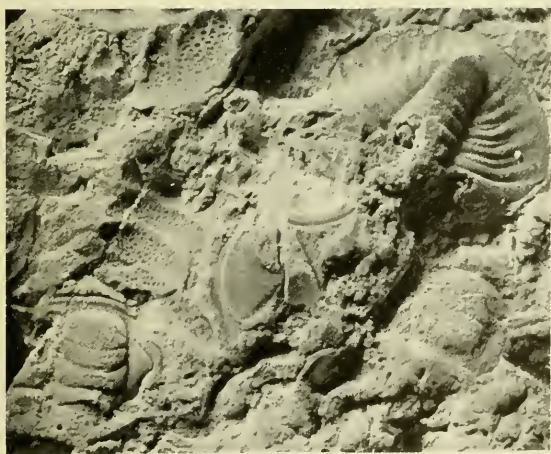
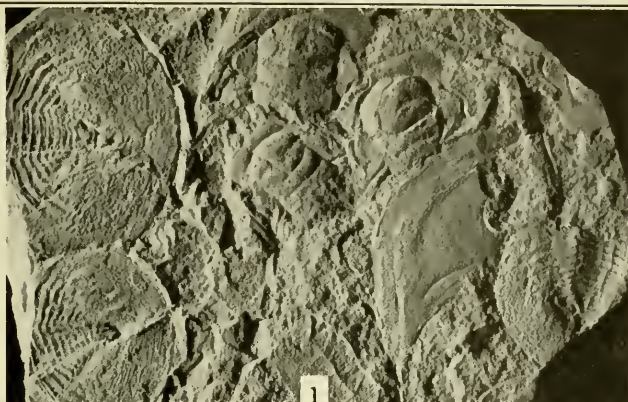
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FIG. 1. (Natural size.) Small slab with cranidia, free cheeks, and pygidia. U. S. National Museum, Catalogue No. 58671.	
2. (Natural size.) Small slab with matrices of cranidia and free cheeks, also pygidia and thoracic segments. U. S. National Museum, Catalogue No. 58672.	

The specimens represented by figs. 1 and 2 are in the collection of the Yale University Museum, New Haven, Connecticut. The plastotypes in the U. S. National Museum bear the locality number 346f, Upper Cambrian: Natural Bridge limestone, 1.5 miles (2.4 km.) north-northeast of Natural Bridge, Virginia, in calcareous shale in Shenandoah limestone.

<i>Saukia stosei</i> Walcott. (See pl. 70).....	384
FIG. 3. (X 3.) Surface of limestone with cranidia, free cheek, and pygidium weathered out in relief. U. S. National Museum, Catalogue No. 58673.	
4. (X 3.) Side view of cranidium and free cheek of fig. 3.	
5. (X 3.) Another view of the pygidium of fig. 3.	

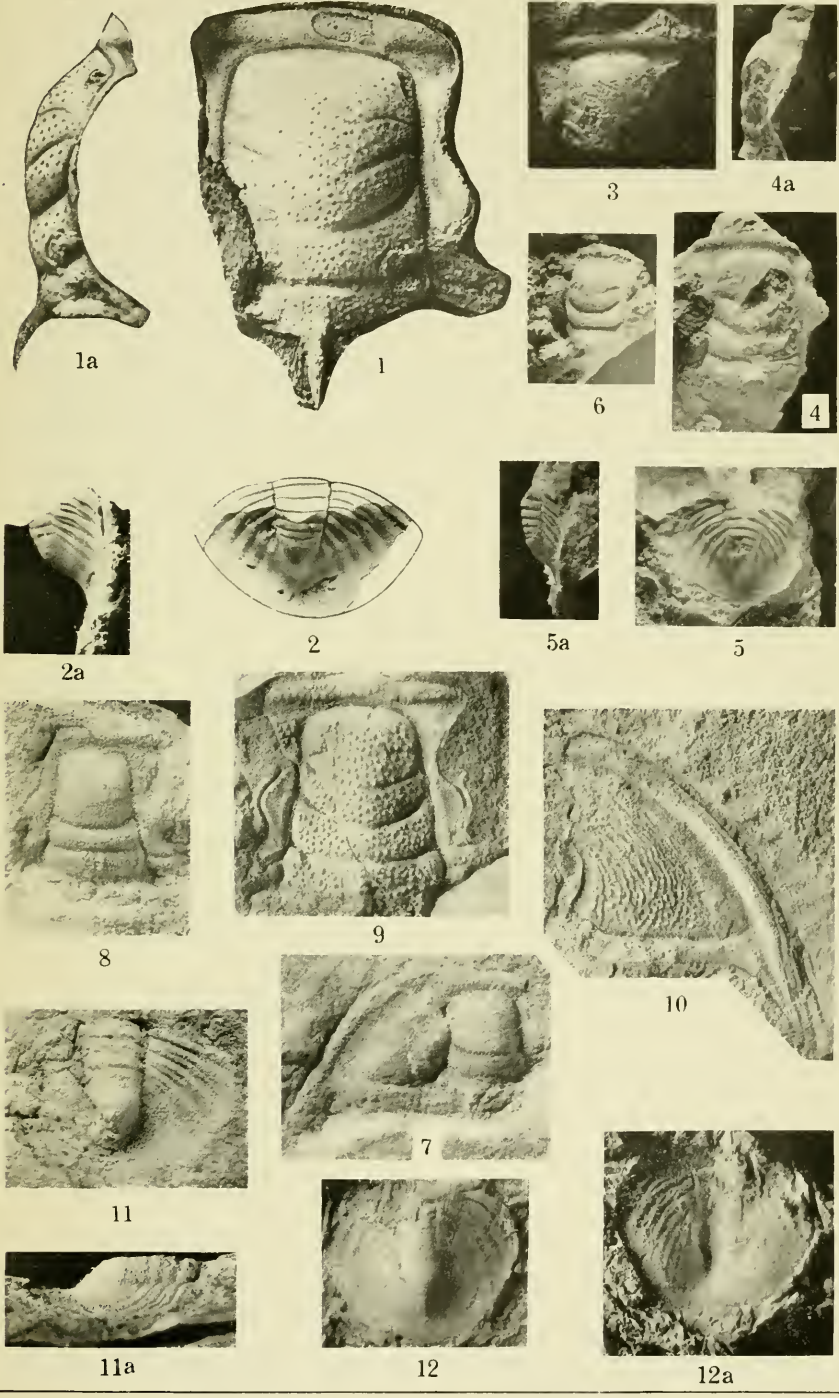
The specimens represented by figs. 3-5 are from locality 59 o, Lower Ozarkian (Ulrich): Conocheague limestone, about 800 feet (240 m.) above the base of the formation in a limestone quarry on point of spur northwest of Scotland Station, Franklin County, Pennsylvania.



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| <i>Calvinella ozarkensis</i> Walcott..... | 389 |
| <p>FIGS. 1 and 1a. ($\times 2$.) Dorsal and side views of large cranidium. U. S. National Museum, Catalogue No. 58674.</p> <p>2 and 2a. (Natural size.) Dorsal and side views of a large broken pygidium. U. S. National Museum, Catalogue No. 60055.</p> <p>3. (Natural size.) Anterior portion of a cranidium with a slightly more convex frontal border than the specimen represented by fig. 1. U. S. National Museum, Catalogue No. 60056.</p> <p>4 and 4a. ($\times 3$.) Dorsal and side views of a small cranidium that is probably the young of this species. U. S. National Museum, Catalogue No. 58675.</p> <p>5 and 5a. ($\times 2$.) Dorsal and side views of a small pygidium from same rock as the cranidium represented by fig. 3. U. S. National Museum, Catalogue No. 58677.</p> <p>6. ($\times 3$.) Dorsal view of a small cranidium from a little higher horizon in the Eminence formation than the other specimens illustrated. U. S. National Museum, Catalogue No. 58676.</p> <p>The specimens represented by figs. 1-5 are from Lower or Middle Ozarkian localities in the vicinity of Eminence, Shannon County; fig. 6 is from Flat River, St. Francis County, both in Missouri.</p> | |
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| <p>FIG. 7. ($\times 2$.) Cranidium with free cheek.</p> <p>8. ($\times 2$.) Type specimen of the cranidium of this species.</p> <p>The specimens represented by figs. 7, 8, 11, and 11a are in the collections of the Museum of the State Geological Survey of New Jersey.</p> <p>9. (Natural size.) Large cranidium from locality 11c, Lower Ozarkian: Lower part of Kittatinny limestone, O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey. U. S. National Museum, Catalogue No. 58678.</p> <p>10. (Natural size.) Free cheek associated with the cranidium represented by fig. 9. U. S. National Museum, Catalogue No. 58679.</p> <p>11 and 11a. ($\times 2$.) Dorsal and side views of pygidium associated with the cranidia represented by figs. 7 and 8.</p> | |
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| <p>FIGS. 12 and 12a. (Natural size.) Matrix and cast from matrix of a crushed pygidium that may possibly be of this species. From locality 59n, Lower Ozarkian (Ulrich): Conococheague limestone. Quarry at Scotland Station, Franklin County, Pennsylvania. U. S. National Museum, Catalogue No. 59680.</p> | |



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