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II

No. 8.—THE SARDINIAN CAMBRIAN GENUS OLENOPSIS IN AMERICA

With Plate 36

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INTRODUCTION

The genus *Olenopsis* has received considerable attention from authors who have written on the stratigraphy and paleontology of the Cambrian strata of the Island of Sardinia, but up to the present it has not been recognized in any Cambrian section where its stratigraphic position in relation to the *Olenellus* and *Paradoxides* faunas could be definitely determined.

The presence of the genus in America has not been announced, although a number of the cranidia of species referred to *Ptychoparia* were very much like the cranidia of *Olenopsis*.

The three species described in this paper give the genus a recognized stratigraphic position over a wide area in North America, and from this it is thought probable that the type species, *Olenopsis zoppii,* occurs in the Cambrian series of Sardinia beneath the Middle Cambrian *Paradoxides* beds, either in passage beds from the Lower to the Middle Cambrian, or in the upper beds of the Lower Cambrian.

Dr. J. F. Pompeckj considered it probable that *Olenopsis* was derived from *Paradoxides,*[1] but with our present information I am inclined to consider that *Olenopsis* is more likely to be a form intermediate between *Holmia* (restricted) and *Paradoxides,* or that the two genera are descendent from the *Holmia* type of the Mesonacidæ.[2] We do not appear to have evidence that *Olenopsis* is stratigraphically above *Paradoxides.* On the contrary it is below the horizon of the Middle Cambrian in Pennsylvania and it is in the passage beds at

[1] *Paradoxides*-Stufe von La Cabitza in Sardinien. Zeitschr. Deutschen geol. Gesellsch., Bd. 53, Heft 1, 1901, p. 19.

[2] Smithsonian Misc. Coll., Vol. 53, No. 6, 1910, pp. 253 and 254.

the base of the Middle Cambrian in Montana, Alberta, and British Columbia.

Protolenus Matthew[1] occurs in the passage fauna between the Lower and Middle Cambrian,[2] and the genus has been compared to *Olenopsis,*[3] but I agree with Doctor Pompeckj[4] that there is not much in common between them, so far as can be demonstrated by the means of comparison available.

Genus OLENOPSIS Bornemann

Olenopsis Bornemann, 1891, Nova Acta Kais. Leop.-Carol. Deutsch. Akad. Naturforscher, Bd. 56, No. 3, p. 450. (Defines and discusses genus.)

Olenopsis Matthew, 1895, Trans. New York Acad. Sci. Vol. 14, pp. 144-145. (Compares *Olenopsis* and *Protolenus.*)

Olenopsis Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, No. 17, p. 141. (Repeats observations in paper of 1895.)

Olenopsis Pompeckj, 1901, Zeitschr. Deutschen geol. Gesellsch., Bd. 53, Heft 1, p. 19. (Compares *Olenopsis* and *Paradoxides,* etc.)

Genotype.—*Olenus zoppii* Meneghini [1888, Memoire R. Comitato Geol. d'Italia, Vol. 3, Pt. 2; Pal. dell' Iglesiente Sardegna, p. 7].

Stratigraphic range.—The type species of the genus occurs in an argillaceous shale and associated sandstones. Their thickness is undetermined owing to the folding and disturbance of the strata.

Olenopsis americanus (p. 243) ranges through about 10 feet (3 m.) of shale and thin-bedded sandstones of the upper portion of the Lower Cambrian or passage beds to the Middle Cambrian.

Olenopsis agnesensis (p. 242) is limited to a band of siliceous shale about 10 feet (3 m.) thick that occurs just above the *Olenellus canadensis* zone[5] and beneath the Middle Cambrian.

Olenopsis roddyi (p. 244) has been found only at one locality as a single specimen in a silico-argillaceous shale of the upper horizon of the Lower Cambrian in association with *Olenellus thompsoni.*

It thus appears that the known stratigraphic range of the genus is from the upper zone of the Lower Cambrian into passage beds leading up to the Middle Cambrian.

[1] Trans. New York Acad. Sci., Vol. 14, 1895, pp. 144-145. Bull. Nat. Hist. Soc. New Brunswick, No. 17, 1899, p. 142.

[2] Proc. Washington Acad. Sci., Vol. 1, 1900, pp. 320, 321, 325-327.

[3] Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, No. 17, p. 17.

[4] Zeitschr. Deutschen geol. Gesellsch., Bd. 53, Heft 1, 1901, p. 46.

[5] Smithsonian Misc. Coll., Vol. 53, No. 6, 1910, p. 318.

Geographic distribution.—The type species, *Olenopsis zoppii,* occurs on the Island of Sardinia at Canal Grande and vicinity. In North America *Olenopsis roddyi* is found on the eastern side of the Continent near Lancaster in the central part of Pennsylvania. On the western side of the Continent *Olenopsis americanus* is found in the northern central part of Montana, and *Olenopsis ? agnesensis* on the line of the Continental Divide near the Canadian Pacific Railway in both Alberta and British Columbia. It is quite probable that if entire specimens of a number of species now represented by cranidia and referred to the genus *Ptychoparia* were available for study other species of *Olenopsis* would be found at approximately the same stratigraphic horizon.

Observations.—Doctor Bornemann distinguishes *Olenopsis* from *Olenus* on account of its having a small, rounded tail-shield with unsegmented axis; by the particularly semicircular outline of the cephalon, the conic, nearly smooth glabella, and 14 or 15 body segments; from *Liostracus,* by the difference in shape of the pygidium, although the similarity of the form of the cephalon is very great.

Among American genera of the family Olenidæ a number of species of the genus *Ptychoparia* have a cephalon more or less closely resembling that of *Olenopsis,* but the marked variation in the thoracic segments and pygidium serves to clearly separate them.

Doctor Bornemann has given a very detailed description of *Olenopsis* and the Sardinian species referred to it, also numerous illustrations. In consideration, however, of the fact that his work is not readily accessible to many students, I am reproducing photographs of a number of specimens of *Olenopsis zoppii,* collected at the type locality, that are now in the collections of the United States National Museum. These will enable the student to make direct comparisons between Sardinian and American species.

I am in doubt about referring *Olenopsis ? agnesensis* to *Olenopsis* on account of the character of the pygidium. In *Olenopsis zoppii* and *Olenopsis roddyi* the pygidium is elongate and slightly marked by transverse furrows on the axis, whereas in *Olenopsis ? agnesensis* the axis of the pygidium is transverse and very distinctly divided into segments by transverse furrows. The entire assemblage of characters in the cephalon and thorax in *Olenopsis ? agnesensis* is such, however, that it is included in the genus pending a study of a considerable group of species that have in each characters of *Olenus, Ptychoparia, Liostracus* and *Olenopsis.*

OLENOPSIS ZOPPII Meneghini

Plate 36, figs. 3-7

Olenus zoppii MENEGHINI, 1882, Proc. Verb. Soc. Tosc. Sci. Nat., July 2, 1882; Fauna Cambriana dell' Iglesiente, p. 163: Note alla Fauna Cambriana, etc. (Idem, Nov., 1883.)

Conocephalites sp. MENEGHINI, 1882, Fauna Cambriana dell' Iglesiente.

Olenus zoppii MENEGHINI, 1888, Mem. Real. Comitato Geol. Italia, Vol. 3, Pt. 2, Pal. dell' Iglesiente Sardegna, p. 7.

Olenopsis zoppii BORNEMANN, 1891, Nova Acta Kais. Leop.-Carol. Deutsch. Akad. Naturforscher, Bd. 56, No. 3, p. 459.

References to the very full description and illustration of this species by Doctor Bornemann are given under the genus *Olenopsis*.

OLENOPSIS ? AGNESENSIS, new species

Plate 36, fig. 2

Olenopsis agnes WALCOTT, 1908, Smithsonian Misc. Coll., Vol. 53, No. 5, p. 214. (Name printed by error as *agnes* in lists of fossils from No. 3 of the Mount Whyte formation.)

The cephalon of this species is much like that of *Olenopsis zoppii*, except that the fixed cheeks are broader and the palpebral lobes smaller. The thoracic segments are of the same character, except that the outward extensions of the pleural lobes are shorter and broader. The pygidium is more transverse and it has the axial lobe divided into segments by four transverse furrows, that are continued out as faint furrows on the pleural lobes.

Olenopsis ? agnesensis differs from *Olenopsis roddyi* in its thoracic segments and pygidium, and presumably in its cephalon. It agrees with *Olenopsis americanus* in having less prolonged extensions of the pleuræ of the thoracic segments, but differs in the details of the cephalon. The most marked difference is in the character of the pygidium which is more like that of *Ptychoparia* or *Liostracus* than that of *Olenopsis*. The greatest point of similarity in the four species is the finely reticulate surface formed of irregular, very minute ridges.

Formation and locality.—Lower Cambrian: (35e) Dark gray siliceous shale forming the lower two feet of 5 (64 feet) of the Lakes Louise and Agnes Section, amphitheater between Popes Peak and Mount Whyte, south of Lake Agnes, south of Laggan, on the Canadian Pacific Railway in western Alberta; (35m) Mount Whyte formation (*Albertella* zone) 3 miles southwest of the head of Lake Louise, on east slope of Mount Whyte, Alberta; and (57t and 58q)

about 250 feet below the top of the Lower Cambrian in gray siliceous shale (102 feet) forming 5 of Mount Whyte formation, Mount Stephen Section, just above the tunnel, north shoulder of Mount Stephen, 3 miles east of Field, British Columbia; all in Canada.

OLENOPSIS AMERICANUS, new species

Plate 36, figs. 8-11

Olenopsis ? sp., WALCOTT, 1908, Smithsonian Misc. Coll., Vol. 53, No. 5, p. 202. (Mention of genus in list of fossils from Gordon Mountain.)

This species is a rare form and is known only by a few fragments of the dorsal shield and several specimens of the cranidium. Its locality has been thoroughly worked on two occasions without securing entire specimens.

The cephalon as restored by uniting the cranidium and free cheeks, has a transverse, semicircular outline with rather strong spines at the genal angles. Marginal border rather broad, slightly flattened, and uniting at the genal angles with the well-defined, rounded posterior border. In front of the glabella the inner margin of the border curves gently backward, narrowing the frontal limb.

Glabella subconical and marked by three pairs of glabellar furrows, the anterior of which are shallow and often obscure. A shallow furrow connects the inner ends of the slightly oblique posterior pair. Occipital ring strong and separated from the glabella by a narrow, shallow occipital furrow. Dorsal furrow about glabella very distinct. Fixed cheeks broad, large, and merging posteriorly into large postero-lateral limbs, and anteriorly into the narrow frontal limb. Palpebral lobes of medium size; a strong, narrow ridge extends from the front end of each lobe across the fixed cheeks to the dorsal furrow opposite the second lobe of the glabella. Free cheek large and rising rapidly from the margin to the base of the medium-sized eye.

A portion of the thorax showing 16 segments indicates that the pleural lobes were about twice as wide as the axial lobe and the pleural furrow of each segment long, strongly impressed, and extending from the inner anterior margin out to the falcate extremity of the pleura.

Pygidium unknown.

Surface formed of a fine irregular network of elevated, very narrow ridges, suggestive of the reticulated surface of the Mesonacidæ.

Observations.—This was the first species of this genus discovered and identified in America. I put the specimen aside in 1905 with

the hope that better material might be found at about the same horizon in British Columbia. Several of the species found in association with *Olenopsis americanus* occur there in the Mount Whyte formation, notably *Acrothele colleni* Walcott, *Wimanella simplex* Walcott, and *Albertella helena* Walcott,[1] but no traces of *Olenopsis americanus* were found. The genus *Olenopsis* is there represented by *Olenopsis ? agnesensis* described in this paper. *Olenopsis americanus* differs from that species in having its palpebral lobes near the transverse median line of the cephalon; its more distinctly defined frontal border that curves slightly backward in front of the glabella; and its narrower frontal limb and, probably, several more segments in the thorax. The differences between *Olenopsis americanus* and *Olenopsis roddyi* are so marked that it will suffice to call attention to the figures illustrating them. It has many characters in common with *Olenopsis zoppii* (Meneghini) but differs in having a larger number of thoracic segments and in surface sculpture as well as minor details.

Formation and locality.—Lower Cambrian: (4v) shale about 200 feet (61 m.) above the uncomformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section,[2] Gordon Creek, 6 miles (9.6 km.) from the South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

OLENOPSIS RODDYI, new species

Plate 36, fig. 1

The general form and relative proportions of the cephalon, thorax, and pygidium are shown by the accompanying illustration, which is a reproduction of a photograph of the type specimen of the species. The cephalon and thorax have been shortened by longitudinal compression. This has materially affected the glabella by crowding back its frontal lobe so as to give it a quadrangular outline, and the palpebral lobes, too, have been pushed back toward the posterior margin.

The marginal border of the cephalon is of medium width, slightly rounded, and uniting at the genal angles with the rounded posterior border of the fixed cheeks before merging into a strong, sharp, narrow, rounded, backward-projecting genal spine.

[1] Smithsonian Misc. Coll., Vol. 53, No. 2, 1908, pp. 19-22.
[2] Idem, p. 202.

The glabella is marked by three pairs of furrows that divide it into two smaller anterior lobes and two posterior lobes. The two middle pairs of furrows are short, transverse, and with a smooth space of about one-third the width of the glabella between them; the anterior furrows have a length of about one-fourth the distance across the glabella, and are not as deep as the other three pairs. The posterior furrows are connected by a narrow, shallow transverse furrow. Occipital furrow, narrow, distinct, and slightly curved forward. Occipital ring strong, rounded, widest at the center, tapering slightly toward the slight furrow separating it from the fixed cheeks.

Fixed cheeks broad, slightly convex in compressed specimens, and with a relatively large palpebral lobe situated well back toward the posterior margin, as shown on the right side of fig. 1. A rather strong palpebral ridge extends from the palpebral lobe across each fixed cheek to the dorsal furrow opposite the second glabellar lobe. Free cheeks narrow within the marginal border. Visual surface of eye elongate, width unknown. Facial sutures not clearly shown; they appear to cut the posterior margin well within the genal spine and to curve forward to the posterior end of the palpebral lobes, around which they curve and then continue obliquely forward to the frontal margin which they cut on a line with a point midway between the glabella and the posterior end of the palpebral lobe.

Thorax with 19 segments. Axial lobe about one-fifth the entire width, rounded, and marked on each side by a shallow, rounded furrow that serves to separate the outer end of the segment as a low, rounded tubercle. Pleural lobes about twice as wide as the axial lobe. The lobes of each segment are formed of an inner straight portion marked by a narrow furrow that starts off the inner anterior margin and extends obliquely across the segment nearly to the posterior margin at the outer body margin of the thorax, beyond which slightly flattened, long, backward-curving spines add about one-fifth to the width of the dorsal shield. The spinose extensions of the posterior segments curve backward more and more until the posterior segment almost encloses the pygidium.

Pygidium very small, lanceolate in outline, and crossed near the anterior margin by a shallow furrow.

Surface of cephalon and body portion of thorax with a somewhat irregular network of very fine, narrow ridges that give the appearance of being a modified form of the reticulated surface so characteristic of the Mesonacidæ.[1]

[1] Smithsonian Misc. Coll., Vol. 53, No. 6, 1910, pl. 28, fig. 7; pl. 37, figs. 4 and 5.

Dimensions.—The only specimen known to me of this species has a length of 18 mm. The relative proportions of the various parts have probably been fairly well retained in fig. 1, although the cephalon and thorax have been shortened and widened by longitudinal compression and flattening in the shale.

Observations.—This fine species was found by Professor H. Justin Roddy at the Fruitvale stone quarry in a dark gray silico-argillaceous shale containing numerous specimens of *Pædeumias transitans* Walcott of the upper portion of the Lower Cambrian fauna. The reasons for placing it in the genus *Olenopsis* are given under notes on the genus.

The specific name is given in recognition of the excellent work of Professor Roddy, of the Normal School, Millersville, who for several years has been studying the areal geology of and collecting fossils in Lancaster County.

Formation and locality.—Lower Cambrian: (12 w) Silico-argillaceous shale, in quarry just west of Fruitvale, 2 miles (3.2 km.) north of Lancaster, Lancaster County, Pennsylvania.

DESCRIPTION OF PLATE 36

PAGE

Olenopsis roddyi Walcott 244

FIG. 1. (× 3.) The type specimen of the species. The cephalon has been compressed so as to shorten it and distort the glabella. Original type presented by Professor H. Justin Roddy, Millersville, Pa., to the National Museum. U. S. National Museum, Catalogue No. 58363.

Olenopsis ? agnesensis Walcott 242

FIG. 2. (× 2.) A somewhat broken specimen showing the character of the species. The free cheek terminates in a short spine. U. S. National Museum, Catalogue No. 58364.

The locality of the type is (35m) Mount Whyte formation (*Albertella* zone), 3 miles southwest of the head of Lake Louise, on east slope of Mount Whyte, Alberta, Canada.

Olenopsis zoppii Meneghini 242

FIG. 3. (Natural size.) View of a natural cast, showing the form of the cranidium and thoracic segments. U. S. National Museum, Catalogue No. 18304.

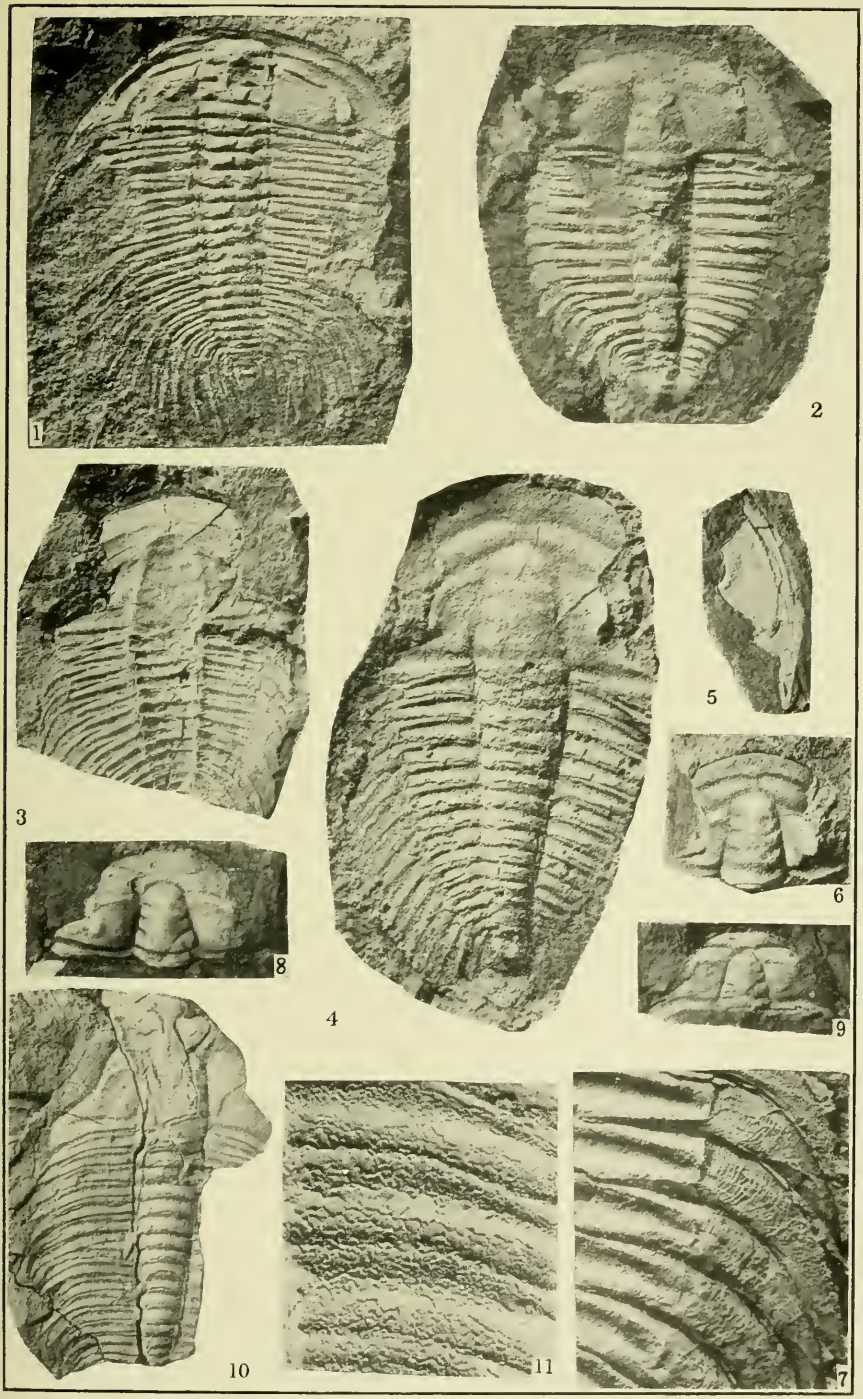
4. (× 2.5.) A nearly entire specimen, illustrating the general characters of the species. U. S. National Museum, Catalogue No. 58365.

5. (Natural size.) Under side of a free cheek. U. S. National Museum, Catalogue No. 58366.

6. (× 2.) A cranidium preserving the form of the glabella, frontal limb, and margin. The ridge crossing the frontal limb at the center was caused by a break in the test. U. S. National Museum, Catalogue No. 58367.

7. (× 3.) Enlargement of several of the falcate extensions of the pleural lobe to show the surface markings of the under side of the doublure of the pleuræ. U. S. National Museum, Catalogue No. 18304.

All of the specimens illustrating this species are from the locality of Canal Grande, Sardinia.



TRILOBITES

DESCRIPTION OF PLATE 36 (Continued)

PAGE

Olenopsis americanus Walcott 243

FIGS. 8. and 9. (Natural size.) Two cranidia that preserve a little of their original convexity. The glabella in both is slightly distorted by compression. U. S. National Museum, Catalogue Nos. 58368 and 58369, respectively.

10. (Natural size.) A fragmentary specimen, showing the greater part of the thorax. U. S. National Museum, Catalogue No. 58370.

11. (×4.) Enlargement of the outer surface as shown in the matrix of the specimen represented by figure 10. U. S. National Museum, Catalogue No. 58371.

All of the specimens illustrating this species are from locality (4v) Lower Cambrian; about 200 feet above the unconformable base of the Cambrian and 75 feet above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, Smithsonian Misc. Coll., Vol. 53, No. 5, 1908, p. 202], Gordon Creek, 6 miles (9.6 km.) from the South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.