NOTES ON CERTAIN ORDOVICIAN FAUNAS OF THE INYO MOUNTAINS, CALIFORNIA

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The purpose of this paper is to describe the faunas and stratigraphy of the Ordovician Barrel Spring and Mazourka formations as exposed in the Inyo range in east-central California.

During the fall of 1931 the writer spent several days collecting in the Inyo range with Dr. John H. Bradley, Jr. The field work was continued during the following winter and spring.

Ordovician rocks outcrop over a large area in the Inyo mountains, mainly in the southern part of the Bishop quadrangle and in the northern part of the Mount Whitney quadrangle. The best exposures for study occur in the vicinity of Mazourka canyon, east of Independence, California.

In 1912 and 1913, Adolph Knopf and Edwin Kirk made a reconnaissance geological survey of a large area in the vicinity of Owens valley which includes the Inyo range.[1] Kirk, in his study of the Ordovician section of the Inyos, recognized four divisions:

"The lowest is the basal sandstone 300 feet thick. Overlying this is a great series of limestones, probably of Beekmantown age. Above these limestones is a series of argillaceous limestones which is equivalent to the upper part of the Pogonip limestone and is of Chazy age. Apparently above these argillaceous limestones there is a series of arenaceous shales which is probably equivalent, at least in part, to the Palmetto formation of Turner. It is possible that rocks of Richmond age also occur in the range."[2]

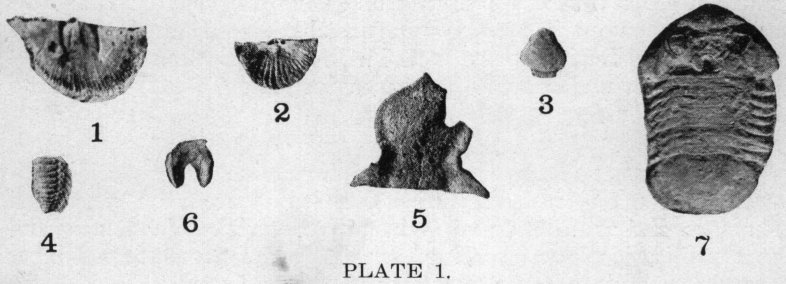

PLATE 1.

[1] Knopf and Kirk, *U. S. Geol. Surv. Prof. Paper 110*, 1918.
[2] *Ibid.*, p. 32.

THE MAZOURKA FORMATION

The term, Mazourka formation, is here proposed to include a succession of argillaceous shales and limestones of lower Middle Ordovician age, 675 feet in thickness, underlain conformably by the Ordovician limestone which Kirk considers of Beekmantown age, and overlain conformably by the Barrel Spring formation. The beds strike north 35 degrees west and dip from 55 to 65 degrees southwest, and are exposed typically in Mazourka canyon between Barrel Spring canyon and the Lead canyon trail. The type section has been measured in an unnamed canyon which is the first tributary canyon entering Mazourka canyon on the east below the Elbow in Mazourka canyon. Two lithologic facies, a lower calcareous shale and an upper argillaceous limestone, mark the formation. The lower 125 feet, constituting the calcareous shale, is interbedded at irregular intervals with thin-bedded lenses of argillaceous limestone. It is dark gray on fresh fracture and weathers to a light gray. The lowest 75 feet is unfossiliferous, but in the overlying 50 feet scattered fragments of crinoids and trilobites occur on weathered surfaces. The shale beds grade into an argillaceous limestone, which is interbedded at infrequent intervals with a few thin shale layers. The limestone is dark gray on fresh fracture and weathers in light and dark discontinuous bands. It is abundantly fossiliferous and continues to the top of the formation.

In the type section the Mazourka formation is overlain with apparent conformity by the basal Devonian quartzite, which weathers white to buff. The absence of the Barrel Spring formation at this place may be due to faulting, since a short distance south of the type section extensive faulting has taken place. Farther south, in Barrel Spring and Mexican canyons, the Mazourka formation is overlain conformably by the basal quartzite of the Barrel Spring formation. The massive Beekmantown limestones, which underlie the Mazourka formation, weather white to buff.

The limestone of the Mazourka formation in most cases appears barren on fresh fracture. The fossils occur on weathered surfaces, and are found mainly in talus material. Weathering and recrystallization have combined largely to obliterate more minute characters and to make identification very difficult. The strata have also been sheared in places.

The Fauna of the Mazourka Formation

The following is a complete list of the fauna collected and identified by the writer from the Mazourka formation, including the forms also collected by Kirk:[3]

****Beatricea** sp. ind.
****(?) Streptelasma** sp. ind.
***Diplograptus** sp.
****Blastoidocrinus carchariedens** Billings
****Prasopora contigua** Ulrich
****(?) Chasmatopora** sp. ind.
****Crania** sp. ind.
****Orthis minusculus** sp. nov.
****Plectorthis mazourkaensis** sp. nov.
****Plectorthis patulus** sp. nov.
***Triplesia** sp.
Ctenodonta hamburgensis (Walcott)
***Modiolopsis** sp.
Pleurotomaria sponsa Billings
Hormotoma sp. ind.
Liospira sp. ind.
***Fusispira** sp.
Maclurites (?) *subannulata* (Walcott)
Maclurites sp. ind.
****Trochonema** sp. ind.
Endoceras proteiforme Hall
****Lloydia obsoletus** sp. nov.
***Nileus** sp.
****Isotelus gigas** DeKay
****Isotelus** sp. ind.
****Bumastus** sp. ind.
****Encrinurus hastula** sp. nov.
****Encrinurus octonarius** sp. nov.
****Cybeloides calliteles** sp. nov.
****Ceraurus infrequens** sp. nov.
Pliomerops barrandei Billings
Leperditia bivia White
****Leperditia nana** Jones
***Leperditella** sp.

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[3] *Op. cit.*, p. 35.
* Included in Kirk's faunal list and not collected by the author.
** Species not collected by Kirk.

The Age of the Mazourka Formation

Most of the new species from the Mazourka formation described in this paper are closely related to known Chazy types from other localities. These together with the Mazourka specimens which fall into previously described Chazy species from other localities constitute about 75 per cent of the Mazourka Fauna.

About 20 per cent of the remaining species have been found elsewhere in rocks of Trenton age. The abundance of gastropods is a notable characteristic of the fauna; six genera are represented, and of these three are extremely common throughout the formation. The Mazourka formation is faunally a unit and undoubtedly of Chazy age.

Correlation with Strata Elsewhere

Kirk correlates the Mazourka formation with the upper Pogonip of the Eureka district, Nevada, described by Hague. The term "Pogonip" has been used in Nevada in various ways. Hague's[4] use of the term includes strata of Beekmantown, Chazy, and Trenton ages, with a maximum thickness of 5,000 feet. Emmons[5] and Spencer[6] used the term "Pogonip" to include beds containing Ordovician fossils between Cambrian strata and the Eureka quartzite, which is stratigraphically lower than a limestone carrying Trenton fossils. Over 15 per cent of the Mazourka species are closely related to species reported by Hague from the middle part of his section. Since this middle part of Hague's fauna is of Chazy age, it would appear that the Mazourka formation may be equivalent, in part at least, to his middle Pogonip. Walcott's faunal list of the upper Pogonip of the Eureka district[7] includes species of Chazy age. About 25 per cent of the species from the Mazourka formation are either identical with or are closely related to species which Walcott reported. The two formations may be partially contemporaneous.

There is a similarity between the fauna of the lower part of the Simpson formation of Oklahoma[8] and that of the Mazourka formation. About 20 per cent of the Mazourka forms are represented in the lower Simpson by identical or related forms. It is probable that the two formations are partly contemporaneous.

The Swan Peak quartzite of Idaho carries a small fauna of

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[4] Hague, Arnold, *Geol. of the Eureka Dist., Nev.; U. S. Geol. Surv. Mon. 20*, pp. 48-54.

[5] Emmons, S. F., *U. S. Geol. Surv. Bull. 308*, pp. 27-29.

[6] Spencer, A. C., *U. S. Geol. Surv. Prof. Paper 96*, pp. 25, 26.

[7] Walcott, C. D., *U. S. Geol, Surv. Mon. 8*, pp. 65-98.

[8] Edson, F. C., *Notes on the Simpson Formation of Oklahoma, Bull. Am. Ass. Pet. Geol.*, vol. 7, 1923, pp. 558-64.

questionable Chazy age. Mansfield gives no faunal list in his papers[9] but Richardson* lists eight forms. This formation is a possible correlative of the Mazourka formation.

A fairly close correlation by means of fauna can be made between the Mazourka formation and the type Chazy formation of New York and Canada. About 50 per cent of the Mazourka forms which have been specifically identified are either identical with or closely related to forms occurring in the Chazy of the eastern section.

THE BARREL SPRING FORMATION

The term, Barrel Spring formation, is here proposed to include a succession of quartzites, impure limestones, and argillaceous shales of Middle Ordovician age, in the Inyo mountains. The formation is 130 feet in thickness, overlain conformably by basal Devonian quartzite and underlain conformably by the argillaceous limestones of the Mazourka formation. The type section has been measured in the south fork of Mexican canyon, which is the second canyon north of Barrel Spring canyon. The beds strike north 15 degrees west and dip from 60 to 70 degrees southeast. They are well exposed in Barrel Spring canyon and in each of the next four canyons to the north. Three lithologic facies: a basal quartzite, an impure limestone, and an argillaceous shale, mark the formation. The lower 41 feet, constituting the quartzite, is very resistant and stands out in bold relief. It is white in color and is unfossiliferous. The overlying 25 feet consists of an impure limestone which is only slightly less resistant to weathering than the quartzite, and is also unfossiliferous. It is dark gray on fresh fracture and weathers to a lighter gray. The limestone beds grade into an argillaceous shale which is 64 feet thick and continues to the top of the formation. It is dark gray to black on fresh fracture and weathers to a reddish-brown color. The shale is highly fossiliferous at certain localities.

Fossils appear in most cases on fresh fracture as an iron replacement which weathers to limonite. The better specimens are preserved as molds and casts. The best locality for collecting is in the exposures of the shale member on the north slope of Barrel Spring canyon about one-half mile east of Barrel Spring.

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[9] Mansfield, G. R., *U. S. Geol. Surv. Prof. Paper 152*, p. 57. *U. S. Geol. Surv. Bull. 713*, pp. 32, 33.

* Richardson, G. S., *Am. Jour. Sci.*, Vol. 186.

Fauna of the Barrel Spring Formation

The following is a list of the fauna collected by the writer from the Barrel Spring formation:

Orthis tricenaria Conrad
Orthis decipiens sp. nov.
Plectambonites angulatus sp. nov.
Orthoceras sp. ind.
Remopleurides occidens sp. nov.
Isotelus gigas DeKay
Isotelus spurius sp. nov.

Five of the seven forms which are present in the fauna of the Barrel Spring formation are either identical with or are closely related to species of Trenton age.

Correlation with Strata Elsewhere

Due to the paucity of the fauna of the Barrel Spring formation and also because of incomplete information concerning Ordovician faunas of Trenton age in western United States, it is impossible to correlate this formation with strata elsewhere in the west. Hague[10] assigns a Trenton age to the uppermost part of his Pogonip formation. It is possible that the Barrel Spring formation is contemporaneous with some part of Hague's upper Pogonip, although no related species occur in common at both localities.

It is also possible that the Barrel Spring formation is the equivalent of some part of the upper Simpson formation of Oklahoma. Although no species occur in common at the two localities, there are two or three species which are distantly related.

ACKNOWLEDGMENTS

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The types described in this paper, the gift of Dr. Bradley and the author, are in the Los Angeles Museum.

[10] Hague, *op. cit.*, pp. 48-54.

DESCRIPTIONS OF SPECIES OCCURRING IN THE MAZOURKA FORMATION

PHYLUM Molluscoidea
CLASS Brachiopoda Duméril
ORDER Protremata Beecher
SUPERFAMILY Orthacea Walcott and Schuchert
FAMILY Orthidae Woodward
SUBFAMILY Orthinae Schuchert and Cooper
GENUS Orthis Dalman

Orthis minusculus sp. nov.
Plate II, Figs. 6, 7

Shell small, semi-oval; sides gently convex or concave just below the cardinal extremities, gently converging for about one-half the length, forming a broadly rounded curve latero-anteriorly, the anterior margin only gently convex. Width of pedicle valve of a cotype 10 mm., length 7 mm. Valves equally convex. The brachial valve is uniformly convex, with a narrow, fairly distinct mesial sinus extending the full length of the shell. The pedicle valve is uniformly convex, with a small portion at the cardinal angles depressed; the beak is large, broadly convex, and appears to overhang the hinge line a little. The surface is marked by twenty simple rounded plications, averaging three plications to three millimeters at the anterior margin. Internal characteristics unknown.

This species resembles *Orthis euryone* Billings, from the Canadian beds of Quebec, except that it has fewer plications, the mesial sinus in the brachial valve is narrow and distinct and extends the entire length of the shell, and the brachial valve is not flat. *O. minusculus* is closely related to *O. ignicula* Raymond, from the Chazy of Valcour Island, N. Y., but it does not have the difference in convexity of valves shown in *O. ignicula*. *O. acutiplicata* Raymond, from the Chazy of Valcour Island, has fewer plications than *O. minusculus*. A close relative seems to be *O. laurentia* Billings, from the Gamachian of Canada. In the description given by Billings, however, no mention is made of a mesial sinus. The difference in relative convexity of valves is greater in *O. laurentia* than in the species here described.

Horizon and locality: Mazourka formation, at the Elbow in Mazourka canyon, Inyo mountains, California.