THE DEVONIAN SECTION ON PINAL CREEK, ARIZONA.[1]

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INTRODUCTION.

Pinal Creek originates in the Pinal Mountains of south central Arizona and flows northward through Globe to Salt River, just above the Roosevelt Reservoir. This latter is some twenty miles distant from the mining camps. Solitude Gulch, Bloody Tanks Wash, Lost Gulch, and others of similar character, unite to form an important tributary to Pinal Creek flowing through Miami. A short distance to the east of Globe the drainage flows east and south to the Gila River. Pinal Creek is thus the master stream of the Globe-Miami region. Its ramifying branches cut many fine sections in their steeper portions and the sparseness of vegetation makes these unusually available for study.

Globe is a thriving modern town partially independent of its mining connections. Most of the mines are located to the north and northeast on Buffalo Ridge and in Copper Gulch. A similar mining area lies to the west and northwest of Miami—a much more typical Arizona mining town a few miles to the west of Globe. The mineralized areas of the region are highly faulted and thus constitute a mosaic of formations[2] in which blocks of Devonian limestone take an important part. These are matched up against other Paleozoics, pre-Cambrian metamorphics, intrusives, and volcanics of various ages. The abundance of these faults makes it difficult to piece out the section, especially since portions of it are apparently unfossiliferous. It is probable, therefore, that systems, other than those now included in the general section, may be represented among the remnants.[3]

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[1]Presented by title before the Ohio Academy of Science, April 6th, 1928.

[2]Ransome, F. L., U. S. G. S. Folio No. 111, 1904, Areal Geol. Map.

[3]Ransome, F. R., The Geology of the Globe District, Arizona. Mining and Scientific Press, Vol. 102, 1911, pp. 747–748.

Location of Section.

The section here discussed is that from which Dr. Ransome collected most of the original Globe Devonian fauna,[4] and one which was found especially fossiliferous during the field work on which the present paper is based. Unfortunately it lacks the exceedingly important fossil, *Pugnax pugnus* which Dr. Ransome found in the Devonian beds of the southeast corner of the Globe quadrangle, and which has been found at various other localities in Arizona.

The Pinal Creek Section is located at an east facing limestone bluff just off the Apache Trail 3¾ miles north-northwest of Globe, and about ¾ of a mile northeast of McLean's ranch. The limestone is faulted and dips as great as 55 degrees S. S. E. were measured. The Devonian is typical Martin limestone[5] lithologically similar to that found on the slopes of Mt. Martin or above the Phelps-Dodge concentrator southeast of Bisbee. This identity is definitely proven by the fauna although at Globe the Martin limestone carries a somewhat different grouping of forms than is characteristic of it in the Bisbee region.

The Pinal Creek Section.

The following section occurs at the Limestone Bluff on the west side of Pinal Creek, 3¾ miles northwest of Globe, Arizona.

Mississippian.

Lower Tornado Limestone.

		Thickness
31.	Limestone, highly crystalline, gray, weathering light gray; some chert. These beds contain crinoid stems together with Mississippian corals and brachiopods	100′ 0″
30.	Limestone hard, dark gray to bluish; it contains some rather poorly preserved corals and the upper part is commonly crinoidal	50′ 0″
29.	Shale, brown to buff, at places reddish and massive. Apparently unfossiliferous	30′ 0″

[4]Williams, H. S., U. S. G. S. Prof. Paper No. 12, 1903, pp. 40–42, and Ransome, F. L., idem., pp. 44, 45; also U. S. G. S. Folio No. 217, 1923, p. 8, and U. S. G. S. Prof. Paper No. 115, 1919, p. 46.

[5]Ransome, F. L., U. S. G. S. Folio No. 112, 1904, pp. 3–4, and Prof. Paper No. 115, 1919, pp. 45–47.

DEVONIAN.

Martin Limestone. Thickness

28. Limestone, hard, bluish weathering buff. Fossils abundant.
Crinoid fragments
Nortonechinus primus F. & F.
Atrypa reticularis (Linnaeus).
Productella hallana Walcott.
Spirifer hungerfordi Hall.
Spirifer whitneyi Hall..... 7′ 8″

27. Limestone, fairly massive, hard, gray to bluish gray, crinoidal.
Crinoid stems
Atrypa hystrix Hall.
Atrypa reticularis (Linnaeus).
Atrypa spinosa Hall.
Spirifer hungerfordi Hall..... 6′ 0″

26. Limestone, massive, gray, abundantly fossiliferous.
The Atrypa bed
Atrypa hystrix Hall.
Atrypa reticularis (Linnaeus).
Atrypa spinosa Hall.
Spirifer hungerfordi Hall.
Spirifer whitneyi Hall..... 2′ 0″

25. Limestone, shaly, gray; somewhat arenaceous and with several chert bands, one of which is at the base..... 5′ 0″

24. Limestone, shaly, gray to buff, argillaceous..... 8′ 4″

23. Limestone, with shaly partings, gray arenaceous. Crinoid segments and a few other fossils occur sparingly.
Crinoid stems
Atrypa hystrix (?) Hall.
Atrypa spinosa Hall.
Atrypa sublepida Verneuil.
Stropheodonta sp.
Spirifer sp..... 5′ 6″

22. Shale, gray and nodular gray limestone which is often shaly. Very fossiliferous.
Alveolites rockfordensis (H. & W.).
Aulopora cf. iowaensis (H. & W.).
Aulopora paucitubulata (?) F. & F.
Cladopora labiosa (?) Billings.
Cladopora sp.
Cyathophyllum cf. minus Roemer.
Heliophyllum solidum (H. & W.).
Hederella alternata (H. & W.).
Macgeea solitaria (H. & W.).
Pachyphyllum cf. levatum W. & F.
Tabulophyllum sp.
Codaster sp.
Hexacrinus n. sp.

		Thickness
	Crinoid stems *Nortonechinus primus* F. & F. *Fenestella diatreta* F. & F. *Atrypa desquamata* Sowerby. *Atrypa duboisi* (?) Verneuil. *Atrypa hystris* Hall. *Atrypa reticularis* (Linnaeus). *Atrypa spinosa* Hall. *Atrypa sublepida* Verneuil. *Cranaella navicella* Hall. *Cyrtia cyrtiniformis* H. & C. *Cyrtina iowaensis* F. & F. *Gypidula cornuta* F. & F. *Leptostrophia canace* H. & W. *Productella hallana* Walcott. *Productella* sp. *Schizophoria striatula* (Schlotheim). *Schuchertella parva* (Hall). *Spirifer orestes* H. & W. *Spirifer subvariocosus* H. & W. *Spirifer whitneyi* Hall. *Spirifer whitneyi gradatus* Fenton. *Spirifer* sp. *Stropheodonta arcuata* Hall. *Stropheodonta* sp. *Strophonella reversa* (Hall). *Bellerophon* sp. *Diaphorostoma* (?) sp. *Floydia concentrica* (?) Webster. *Straparollus circinatus* F. & F. *Tentaculites* sp. *Autodetus slocomi* F. & F.	18′ 0″
21.	Limestone massively bedded, blue to gray, arenaceous. Somewhat crinoidal and fairly fossiliferous. *Zaphrentis* sp. *Crinoid stems* *Atrypa reticularis* (Linnaeus). *Spirifer* sp.	12′ 6″
20.	Shale, gray to brown, weathering buff. Some thin limestone lenses occur in the shales	12′ 0″
19.	Limestone, massive, hard, arenaceous and brown in color	2′ 8″
18.	Limestone, crinoidal, gray, arenaceous. *Crinoid stems* *Atrypa hystrix* Hall. *Atrypa spinosa* Hall	2′ 0″
17.	Sandstone, calcareous, gray, cross-bedded	3′ 0″
16.	Shale, gray weathering to buff	10′ 0″
15.	Limestone, shaly, gray, somewhat crinoidal	2′ 0″

		Thickness
14.	Limestone, an uneven layer of gray limestone filled with crinoid stems, many of which are large. *Crinoid stems and plates*	0′ 3″
13.	Limestone, fairly massive, gray, often nodular and occasionally shaly. This bed is somewhat crinoidal	6′ 0″
12.	Limestone, gray, filled with crinoid fragments. *Crinoid stems and fragments* *Atrypa duboisi* (?) Verneuil. *Atrypa reticularis* (Linnaeus). *Atrypa spinosa* Hall. *Cranaena iowaensis* (?) Calvin. *Leptostrophia canace* (H. & W.). *Schizophoria striatula* (Schlotheim). *Schuchertella coloradoensis* Kindle. *Schuchertella* sp. *Spirifer macbridei* Calvin. *Spirifer whitneyi* Hall	0′ 3″
11.	Limestone, thin bedded, nodular, gray arenaceous, with a few crinoid segments scattered through it. *Atrypa reticularis* (Linnaeus). *Leiorhynchus nevadaense* Walcott. *Pentamerella* sp. *Schuchertella parva* (Hall). *Stropheodonta* sp. *Spirifer whitneyi* Hall. *Strophonella hybrida* H. & W	8′ 4″
10.	Sandstone, massive, medium to coarse, cross-bedded, hard, gray weathering brown	13′ 3″
9.	Limestone, shaly arenaceous, gray to brown	2′ 0″
8.	Limestone, laminated, often thin-bedded, drab to slate colored	1′ 10″
7.	Limestone, massive, compact, hard, gray, weathering buff	4′ 8″
6.	Limestone, massive, compact, hard, arenaceous, gray weathering to buff	14′ 6″
5.	Limestone, massive, compact, hard, brown to pink and gray weathering to buff	14′ 0″
4.	Shale, argillaceous, gray to purple	3′ 0″
3.	Limestone conglomerate, hard drab pebbles in a brown matrix, all compact and hard. Some chert	4′ 0″
2.	Limestone, massive, compact, hard drab, weathering light gray	35′ 0″
1.	Covered interval to Pinal Creek, at right angles to dip	12′ 0″

No fossils were found in numbers 1 to 10 of the above section and these may not belong to the Devonian. About 200 yards down the stream the Pinal schists are exposed and overlying them with angular unconformity are conglomerates and sandstones but these have not been included in the measurements here given.

Faunal Discussion.

The Martin limestone fauna, occurring abundantly in bed 22 and sparingly in several of the others in the above section, is characterized by fewer corals and more brachiopods than commonly occur in this formation at Bisbee where several horizons might be described as veritable coral reefs. It is, however, the characteristic Martin fauna in every respect and as such is widely distributed over Arizona. Faulting has cut out so many beds at different localities that the complete section and fauna of the Martin will only be known when the whole south-western Devonian has been systematically covered in one complete and exhaustive study.

The fauna is the same as the typical Iowa upper Devonian and many of the Arizona forms can be matched by species from the Hackberry (Lime Creek) shales at Hackberry Grove, Iowa. Dr. Walcott[6] identified with Iowa forms a number of the species from the Great Basin but the identity of the Arizona fauna with the upper Devonian of Iowa was first pointed out by H. S. Williams[7] and this has been confirmed by others who have had an opportunity to examine such collections as have been made in both places. This relationship is becoming more apparent with every new collection and many of the species mentioned in the section above, when compared with specimens from Hackberry Grove, are indistinguishable. This does not appear to be true of any other fauna with which the Hackberry has been compared. As observed by C. L. and M. A. Fenton,[8] there is a certain faunal relationship existing between the Hackberry and the upper Devonian of other parts of North America. This was long ago recognized by C. S. Prosser and others, and has been the basis on which the supposed identity of some closely related forms has been established. It has likewise influenced the distribution of land and sea on the paleographic maps of the time.

In Dr. Walcott's Devonian collection from the Eureka and White Pine Districts of Nevada,[9] more than half of the species are from the lower part of a 6000 foot limestone. More than half of the remainder, or 61 species, are from the upper part of the same limestone. Many of these latter, and about

[6]U. S. G. S. Mono. VIII, 1884, pp. 274–278.
[7]U. S. G. S. Prof. Paper XII, 1903, p. 42.
[8]The Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian, 1924, p. 17.
[9]U. S. G. S. Monograph VIII, 1884, p. 4–8, 274–278. Also Monograph XX, 1892, pp. 325–330.

a third of those from the overlying 2000 feet of shales (White Pine), indicate the presence of the Martin fauna. Dr. Walcott himself says that "there is little doubt but that future collections from the area of the Great Basin will give a very complete series of species, and still further increase the number of species common to the eastern and central (or Atlantic and Mississippi) areas and the western or Rocky Mountain area."[10] There is thus forecast the possibility of additional and larger collections to be made from the higher Devonian beds of Nevada and the ultimate segregation of the Martin fauna, the presence of which is certainly suggested by the list of species already known from that region. The success of such an undertaking has become more probable since J. S. Diller[11] found part of the Martin fauna in northern California and its wider distribution becomes evident.

Although many Hackberry species resemble those from other regions, notably the East and the North, "close examination shows that, with few exceptions, they present apparent and constant differences."[12] It is probable that this is more applicable to the brachiopods but it may eventually be found to be equally true of many of the other fossil forms found throughout the southwestern Devonian province. If this is a fact, as it appear to be, the Arizona forms identified as *Schizophoria striatula* Schlotheim should be returned to *S. iowaensis* (Hall) and the western *Pugnax pugnus* (Martin) should be either *Pugnoides calvini* F. & F. or *Pugnoides solon* (T. & S.) as Fenton and Fenton[13] have done with the Hackberry forms in Iowa. The Martin fauna, when completely known, will probably exceed the Hackberry in richness of species, but the Iowa fauna is now much better known and mostly in a state of perfect preservation. This latter is only partially true of the Martin fauna. The Hackberrry of Iowa should therefore be used as the standard of comparison for this southwestern or Martin fauna and for all others supposed to contain identical species. A related fauna, probably a later recurrent phase of it, occurs in the Ouray limestone of Colorado[14] and abundantly in the Percha shale of the southwestern part of New Mexico.[15]

[10]U. S. G. S. Monograph VIII, 1884, pp. 7, 8.
[11]Am. Jour. Sci., 4th Ser., Vol. XV, 1903, p. 348.
[12]Fenton, C. L., and Fenton, M. A., Op. cit., p. 17.
[13]Op. cit., pp. 83–85, 125–129.
[14]Kindle, E. M., U. S. G. S. Bull. 391, 1909, pp. 1–14.
[15]Gordon, C. H., and Graton, C. L., Am. Jour. Sci., 4th Series, Vol. XXI, 1906, pp. 394–395. Idem Abs. Jour. Geol., Vol. XV, 1907, pp. 91–92. Also Lindgren, W., Graton, L. C., and Gordon, C. H., U. S. G. S. Prof. Paper 68, 1910, p. 228.

The territory intervening between the region in which the Martin occurs and the Iowa-Missouri Devonian region is unmarked by outcrops of this age. A large part of that territory, however, has been so frequently depressed and covered by marine invasions, bringing in the later sediments, that any existing Devonian remnants are deeply buried beneath Mississippian or later formations. Although it is probable that species occur in Arizona which may not be found in Iowa, and vice versa, still the relationship between the Martin fauna and that of the Hackberry of Iowa is too intimate to admit of any other interpretation than a direct communication between the two. Some of the Martin-Hackberry species, or closely related forms, reached the eastern part of the North American continent by late Devonian time, but the fauna as a whole did not get farther in that direction than Iowa, its most characteristic species being entirely lacking in the New York upper Devonian. The probability is, therefore, that the migratory route to the East, for such species, or their varieties, as reached northern Michigan and New York, was not by way of Iowa but by some more roundabout way, such as the Mackenzie valley, where these same southwestern species that are absent in New York also appear to be wanting.

It has been pointed out, especially by Professor Schuchert,[16] that the southwestern upper Devonian is an Eur-Asiatic fauna. However, it should also be noted that when the epicontinental sea, in which this fauna was prevalent, extended uninterruptedly from the Pacific across northern Mexico, California, Nevada, and Arizona northeastward to Iowa and Missouri, it was one of the great Devonian embayments of the continent and dwarfed to comparative insignificance the eastern Devonian invasion with the fauna that is usually regarded as more or less typically American. The Martin-Hackberry fauna is therefore as much at home on this continent as it is in Europe and only a little less so here than in Asia. It would probably more nearly express the truth to consider the whole region from the central and western part of North America, across Asia to Europe as one great Devonian province and add the name of this continent to that used by Schuchert, making it the Eurasio-American province.

[16]Am. Jour. Sci., 4th Ser., Vol. XV, 1903, p. 348.