

SOME DEVONIAN SECTIONS IN SOUTHEASTERN ARIZONA
AND THEIR CORRELATION

by

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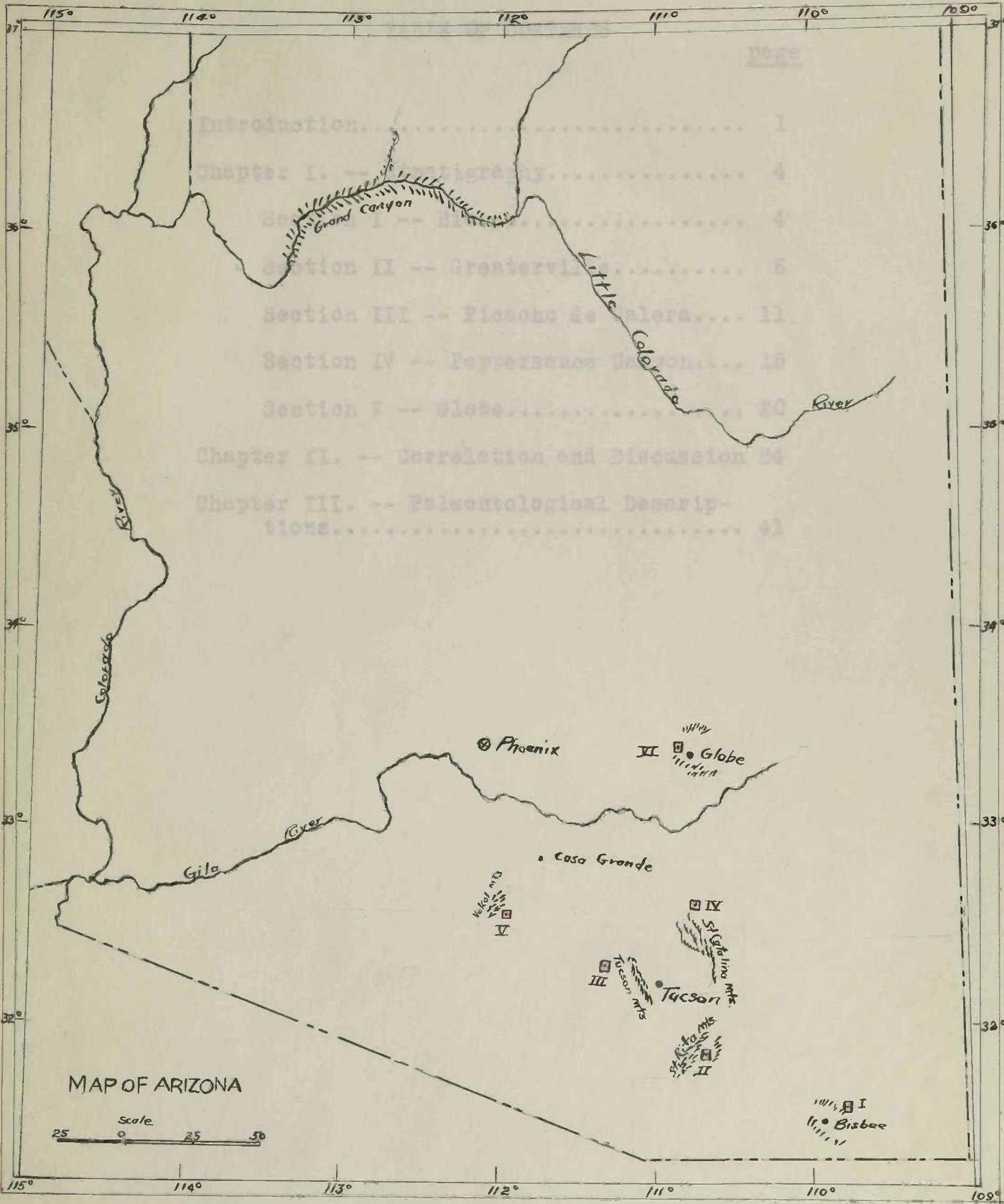
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MAP OF ARIZONA

Scale
 25 50

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INTRODUCTION

The Devonian beds which extend through central Arizona in a north-south belt are made up predominately of limestone, but in many localities shaley and sandy members are abundant. These beds, attaining a moderate total thickness, have been hitherto considered to carry only the characteristic fossil fauna of the Martin limestone of the Bisbee district, and have been considered as a whole the equivalent of that formation. To the east, along the New Mexico border, the Devonian strata, known as the Morenci formation, consist mainly of shale and probably represent the equivalent of the Percha shale of the neighboring state. Northward in the Grand Canyon section, although pre-Mississippian erosion has removed much of the Devonian formation, there is sufficient evidence of it, as the Temple Butte limestone, to establish its stratigraphic relations and lithological character.

It is the purpose of this paper to present a report of a few observations made in various Devonian sections in southern and central Arizona, previously considered entirely as the northward extension of the Martin formation of Bisbee, and to set forth as distinct faunal and lithological units certain strata that hitherto have been considered as part of that well-defined formational unit.

The paper includes, aside from a few introductory paragraphs: (1) the detailed stratigraphic and faunal description of several Devonian sections, as indicated on Plate I; (2) correlation of these individual sections with each other, and with other well-established Devonian formations; and (3) a description of fossil additions to the present Devonian fauna of Arizona.

THE TOPOGRAPHIC PROVINCES OF ARIZONA¹

The State of Arizona is generally divided into three topographic divisions: the plateau region, the mountain region, and the desert or bolson region. The plateau region occupies the northeastern part of the state and consists essentially of horizontal strata of Paleozoic and younger age, covered here and there by flows of basalt.

Joining the southwest limit of the plateau region, along a southeasterly line from Grand Wash Cliffs to the New Mexico border a few miles northeast of Clifton, is the second topographic division, the mountain region. This region is essentially a broad zone, from 70 to 150 miles wide, of short, nearly parallel ranges among which are the Dragoon, Chiricahua, Whetstone, Pinaleno, Galiuro, Santa Catalina, Pinal, Superstition, Ancha, and Mazatzal, extending diagonally across

¹After F. L. Ransome.

the state from the southeast corner to the Colorado River. Most of these ranges consist of quartzites and limestones of Paleozoic or earlier age, resting on the basement rocks. Diabasic and monzonitic intrusions, as well as lava flows are abundant in these short ranges. Structurally these mountains are characterized by the dominant part played by faulting as compared to folding.

Adjoining the mountain region on the southwest is the third topographic division, the desert or bolson region, which also contains numerous short mountain ranges of prevalent northwesterly trend. In this region, however, most of the ranges are separated by broad detrital plains, underlain by fluviatile and lacustrine deposits of later geologic age, or by uneven igneous lowlands partly covered by gravels and flows of lava.

Situated in the second and third great topographic divisions are the several Devonian sections studied by the writer, the discussion of which will comprise the following chapters of this paper.

CHAPTER I.

STRATIGRAPHY

SECTION I -- BISBEE

The Devonian formation, represented as the Martin limestone, here has hitherto been taken as a basis for correlation for all the Devonian rocks of Arizona.

Ransome² has defined the Martin limestone, typically exposed on Mount Martin, as being a thickness of 340 feet of limestone of "moderately thick, usually dark grey beds," underlain by the Abrigo limestone and underlying the Escabrosa limestone, both relations being those of apparent conformity.

The following section of the Martin limestone has been compiled from Ransome's report:

- Escabrosa limestone
2. Dark grey, compact limestone with occasional beds of lighter hue, fossiliferous.....170 feet
 1. Preponderant dark limestone with here and there beds of lighter hue, and calcareous shales of decided pinkish tinge.....170 feet
340

²Ransome, F.L., Geology and Ore Deposits of the Bisbee Quadrangle: U.S.Geol.Survey Prof.Paper 21, p. 33.

Abrigo limestone.

Several collections of fossils were made by Ransome from this section and the following forms were identified by Prof. H. S. Williams:³

Acervularia davidsoni E&H	Cyathophyllum caespitosum
Pachyphyllum woodmani (White)	Atrypa reticularis Linn.
Cladopora prolifica (H&W)	Cyrtia cyrtinaeformis(H&W)
Stromatopora erratica	Dielasma calvini (H&W)
Schizophoria striatula(Schol.)	Stropheodonta demissa Conrad
Productella speciosa Girty	Stropheodonta perplana(Conrad)
Delthyris consobrina(d'Orb)	Strophonella caelata Hall
Spirifer cf. jeremjevi Tsch.	Lononomena
S. hunferfordi Hall	Platyceras
S. crestes Hall	Pleurotomaria
S. cf. eurytienes Owen	Bellerophon
S. whitneyi Hall	Leperditia

Many of the above forms are typical of the fauna of the Hackberry Stage⁴ of Iowa. Prof. Williams says⁵ of the fossils collected from the Martin limestone at Globe: "...all twelve are represented in the fauna of the Lime Creek shales (Hackberry Stage)." Thus it is apparent that the Martin limestone contains the expression of the Hackberry Stage of the upper Devonian in Arizona, and it will be thus considered in any correlations that follow.

³Idem., pp. 36-37

⁴Fenton, M.A. and C.C., Hackberry Stage of the Upper Dev.: Publ., Univ of Mich., 1924.

⁵Ransome, F.L., U.S.Geol.Survey, Ray Folio 217, p. 8, 1923.

SECTION II -- GREATERVILLE

Greaterville is located about three miles east of the crest of the Santa Rita mountains, fifty miles south of Tucson, in the rugged foothills on the southeastern flank of the range.

The Paleozoic and Mesozoic sedimentaries in the region have been greatly disturbed by intrusions of granite-porphry and, in many places, are faulted into very steep attitudes, forming the steep-sided ridges and deep valleys characteristically formed by faulting and subsequent erosion.

The section of Devonian rocks studied by the writer is situated near the Reese camp (Conglomerate mine) on a long, steep-sided, limestone ridge on the south side of Fish canyon, some two and one-half miles wouthwest of Greaterville. Prof. W. P. Blake⁶ says, presumably of this locality:

"Near Greaterville in Prince County (Santa Cruz County) on the east side of the Santa Rita mountains I have found a locality of Devonian fossils in limestone, and have collected, Atrypa reticularis, Spirifer hungerfordi, Bellerophon, and the coral Acervularia davidsoni, besides others not yet determined. These occur in a massive bed of light colored limestone, standing nearly on edge, contiguous to a thick stratum of limestone conglomerate (Glance conglomerate) made up of pebbles of limestone derived from some older beds."

⁶Blake, W.P., Geology of Arizona: Amer. Jour. Sci., Vol. XXVII, p. 164, 1901.

F. C. Schrader⁷ reports on an outcrop of Paleozoic rocks in the vicinity of Greaterville, much folded and faulted, and from which the following fossils were collected:

- | | |
|---------------------------|---------------------------|
| Acervularia davidsoni E&H | Amplexus sp. |
| Acervularia inequalis H&W | Atrypa reticularis Linn. |
| Cladopora prolifica (H&W) | Spirifer hungerfordi Hall |

The exact locality from which the above collection was made was two and one-half miles S 20° W from Greaterville, in the upper part of the ridge between Fish and Sawmill canyons. The section examined by the writer in this locality is as follows:

Section at Reese Camp

Limestone conglomerate, probably Glance conglomerate of Comanchian age

- | | | |
|--|------------|------|
| 3. Moderately thick-bedded, compact, gray to black, fossiliferous limestone with many chert bands... | 130 | feet |
| 2. Light gray, crystalline limestone..... | 120 | " |
| 1. Finely granular, gray limestone with some shale beds in places..... | 40 | " |
| Thin-bedded, black and brown mottled limestone, Cambrian..... | 20 | " |
| | <u>310</u> | " |

Aside from some few Favosites remains in the lowest strata of the above Devonian section, the fossils are confined to the upper portion of the section, particularly to a horizon some fifteen to twenty feet from the top of the section. Here there is a well-defined zone of well-silicified

⁷Schrader, F.C., Mineral Dep. of the St. Rita and Patagonia Mts., Arizona, U.S. Geol. Survey Bull. 582, pp. 47-49, 1915.

fossils, in the main consisting of colonial corals and partaking of a coral reef aspect. It was from this horizon that the following collection was made:

Acervularia davidsoni E&H	Atrypa reticularis Linn.
Amplexus sp.	Spirifer hungerfordi Hall
Zaphrentes sp.	Spirifer sp.
Pachyphyllum woodmani(White)	Spirifer orestes H&W
Cladopora prolifica H&W	
Tabulophyllum sp.	

The writer has also examined an outcrop of Devonian strata at the North Mowry mine in the Patagonia Mountains south of Greaterville.⁸ The typical coral reef horizon described at Reese camp is also well shown here, near the top of the section. Many well-preserved forms have been seen here, including:

Acervularia davidsoni	Spirifer hungerfordi
Pachyphyllum woodmani	Spirifer orestes
Cladopora prolifica	Atrypa reticularis

Due to the fact that there is considerable slumping in the upper part of the section, the exact thickness could not be determined, but it is the writer's opinion that it is somewhat less than three hundred feet. The lithological character of the section, however, is practically identical with that of the section at Reese camp.

It is evident from the above descriptions that both the Greaterville and Mowry mine sections of the Devonian are, both lithologically and faunally, the equivalent of the Martin limestone at Bisbee, and represent the north

⁸Schrader, F.C., op. cit., p. 49.

western extension of the typical Martin formation.

Regarding the Devonian formations in the vicinity of Greaterville, the following abstract of a paper read by C. R. Stauffer before the Geological Society of America,⁹ is given:

"During a recent study of the Devonian of Arizona, an unusual thickness was found in the Santa Rita Mountains, just south of Greaterville. A careful measurement of the section showed 1550 feet of hard, dark grey to black limestone with some shale. While the upper 300 feet carries the familiar fossils, the balance of the limestone is mostly barren, except the lower one-third which was found to contain a fauna very different from that of the usual Martin limestone, and at once marked it as much older. This lower fauna somewhat resembles that found by Kindle in the Jefferson limestone of Montana, although it has a greater variety of Mollusca and fewer Brachiopoda. The formation carrying this older fauna in Arizona may be called Santa Rita limestone, and its age is probably Middle Devonian."

The writer has examined the Paleozoic exposures in the vicinity of Greaterville and has nowhere found any indication of the so-called Santa Rita formation. Going directly south from Reese camp, south of Greaterville, a high ridge,¹⁰ extending northwest and southeast, is encountered, the crest of which is made up of limestone conglomerate underlain unconformably by the Martin limestone. About three hundred feet of the Martin limestone is exposed on the southwest flank

⁹Stauffer, C. R., Dev. Section in the Santa Rita Mts. of Arizona: Abst. Geol. Soc. of Amer., Vol. 38, No. 1, p. 133, Mar. 1927.

¹⁰Schrader, F. C., op. cit., Plate I.

of the ridge, the strata dipping steeply to the east. Near the bottom of the gulley, apparently following a fault line, at the bottom of the ridge, a sharp fold is revealed. Upon ascending a second ridge, parallel to the first but much lower, to the flat crest, black limestone strata were encountered dipping to the east and yielding unmistakable Pennsylvanian fossils. Among the forms collected here are Productus costatus, Squamularia perplexa, Composita subtilita, Euomphalus, Lophophyllum proliferum, and spines of Archeocidaris. On the southwest flank of the ridge the beds are exposed in descending sequence to the bottom of Sawmill Canyon, where the red Cambrian sandstones and limestones are seen.

Disregarding the fault that drops the Pennsylvanian beds topographically below the Devonian limestones, and considering the sequence a normal one, the thickness of strata between the Devonian and Cambrian beds would total some 1500 feet.

It is possible that Dr. Stauffer has disregarded the faulted structure, so characteristic of the region and so evident here, and considered the sequence as normal; and noticing the similarity of the Pennsylvanian forms to forms typical of the Middle Devonian, decided that this mistaken thickness was an expression of the Middle Devonian in Arizona.

Examination of a Paleozoic section in the near-by Patagonia Mountains also failed to reveal any indication of Middle Devonian strata.

SECTION III -- PICACHO DE CALERA HILLS

The Picacho de Calera Hills are located about twenty-five miles northwest of Tucson on the great intermont detrital plain between the Tucson and Silver Bell mountains. They consist of two isolated hills very close together and joined by a low saddle. The westernmost hill is composed of Pinal schist overlain by Bolsa Quartzite (Cambrian) dipping steeply to the east. The saddle between the two hills is composed of Cambrian limestones conformable in dip to the underlying quartzites, and on the western slope of the easternmost hill the Devonian, Mississippian, and Pennsylvanian formations are found in conformable succession, also dipping to the east. Basic intrusions in the form of sills are evident in some of the formations, and numerous dip faults disturb the continuity of the sediments, particularly on the eastern hill.

Jenkins and Wilson¹¹ say of the Devonian formations here, which in a columnar section they represent as having a thickness of three hundred thirty feet:

"Overlying the Cambrian beds is a series of limestones which are more or less fossiliferous. Undoubtedly most of these limestones are of Carboniferous age. The lower portion may, as in other portions in Arizona, be Devonian."

¹¹Darton, N.H., A Resume of Arizona Geology: Univ. of Ariz., Bull. 119 (Geol ser.3) p. 285, 1920.

Of the Devonian formations Darton¹² says:

"This formation (Abrigo limestone) is overlain by massive limestone and limey shales carrying abundant *Atrypa reticularis* (Devonian), and the overlying massive limestones are of Carboniferous age."

In studying the Devonian formations in the Picacho de Calera Hills, the writer has found them to have an aggregate thickness of three hundred ten feet, and to be separated from the underlying Cambrian limestones by a thin layer of calcareous sandstone containing well-rounded grains suggestive of eolian origin, and to be overlain conformably by the massive, gray Mississippian limestone. The detailed section is as follows:

	Approx. <u>feet</u>
9. Massive, hard, gray limestone; unfossiliferous....	150
8. Yellow to brown calcareous sandstone, weathers to soft surface; unfossiliferous.....	25
7. Gray limestone, in places weathered to dark brown; fossiliferous.....	80
6. Thin band of chert.....	0-6"
5. Gray limestone containing fragments of brachiopods	6
4. Brown, calcareous sandstone with well-rounded grains; replete with fish remains.....	1-1½
3. Black dolomite, slightly fossiliferous.....	25
e. Yellow, crystalline limestone, appearing sandy on the weathered surface, interbedded with flaggy blue limestone; numerous Algae.....	
2. d. Flaggy, blue limestone.....	40
c. Bedded, blue gray limestone, beds 3-4 feet thick; numerous corals.....	
b. Blue gray limestone in beds 2 feet thick.....	
a. Talus.....	
1. Yellow, calcareous sandstone with well rounded grains, grading into limestone with irregular lenses of well-rounded sand grains.....	<u>2-4</u>
Pink, crystalline Cambrian limestone. Tot. Approx..	310 feet

¹²Jenkins, O.P. and Wilson, E.D., A Geol. Reconnaissance of the Tucson and Amole Mts.: Univ. of Ariz. Bull. 106 (Geol. ser. 2) pp. 1-8, 1920.

The thin bed of calcareous sandstone at the base of the Devonian section contains no evidence of organic remains. However, its peculiar lithologic character presents an interesting problem regarding its probable origin. The decidedly well-rounded, equidimensional sand grains, in many places comprising the entire thickness, are not persistently the main constituent of the bed. Calcareous material is abundant, appearing mainly as the cement, but here and there present as irregular lenses or blotches suspended in which is an aggregate of well-rounded grains. Whatever may have been the origin of the well-rounded sand grains, their form suggesting that it was probably eolian, it is very evident that wind was not the agent of deposition. The cross-bedded nature of the stratum in some places indicates a shallow water deposition, but the intermingling of sand and calcareous material suggests a limited and inconstant supply of detritus. An arid climate during the transgression of the Upper Devonian sea, with the wind as the main transporting agent for land waste, may have brought about such a form of sedimentary deposit well removed from the supply of detritus.

In the moderately thin-bedded, blue limestone that overlies this sandstone, an interesting fauna is found. Small, linear blotches, probably Favosites, are abundant in many of the beds and in certain beds large and small Algae are abundant. The presence of many large Cryptozoans suggests

that the strata may be older than the Devonian, but the discovery of many specimens of a Zaphrentoid coral, probably of the genus Hallia, along with numerous specimens of Favosites sp., in this limestone, establishes the beds as probably of Devonian age.

The sandstone that overlies these blue limestone strata is very similar to the basal sandstone. Composed, for the most part, of well-rounded, well-classified sand grains, its calcareous nature is, nevertheless, very evident. It probably represents a recessional moment in the movement of the Devonian sea. Abundantly distributed through this bed are fragments of Ptyctodus aff. calceolus, among which two teeth of Cladodus sp. and a single tooth of Lambodus sp. were found.

This sandstone yields the first evidence of a vertebrate fauna with such stratigraphic and faunal relations in Arizona.

In the overlying grey limestone, in places where the beds are metamorphosed to a soft, easily broken material, abundant, well-preserved forms are found of which the following forms have been identified:

Spirifer robustus Web.	Atrypa reticularis Linn.
Spirifer suborestes Web.	Productella Hallani Walcott
Spirifer whitneyi Hall	Schizophoria striatula
Spirifer orestes (H&W)	(Scholtheim)
Cyrtia cyrtinaeformis (H&W)	Single coral
	Crinoid stems

For the most part the limestone is very hard and yields only a few weathered forms of S. whitneyi, Atrypa reticularis, and parts of Crinoid stems.

The brown, calcareous sandstone and the massive, grey limestone forming the upper portion of the section are unfossiliferous except for numerous tiny crinoid stems in the limestone. Although these upper members are unlike any other beds in Devonian section studied, there is a certain similarity between the sandstone here and a sandstone in the Peppersauce section that occupies the same stratigraphic position. Provisionably, then, the upper portion of the Picacho de Calera section will be regarded as the equivalent of the upper portion of the Peppersauce Canyon section, although the latter section does carry a unique fauna.

SECTION IV -- PEPPERSAUCE CANYON

Peppersauce canyon is situated on the northeast side of the Santa Catalina mountains, on the Oracle-Mount Lemmon road, about ten miles from the village of Oracle and some forty-five miles from Tucson. The topography of the region is that of steep-sided ridges and deep valleys, more or less the result of disturbances that have tilted the sedimentary series at steep angles and subsequent erosion that has sculptured along the fault lines.

Here, resting on the Apache group, the entire Paleozoic series is exposed, excepting the Ordovician and Silurian, from the Cambrian through the Mississippian and probably into the Pennsylvanian, in a conformable series some two to three thousand feet thick.

The Devonian rocks in the Santa Catalina range have been reported by A. A. Stoyanow,¹³ and also, according to F. L. Ransome,¹⁴ by C. F. Tolman in an unpublished manuscript. W. P. Blake¹⁵ noted the presence of Devonian rocks in this region, and F. L. Ransome¹⁶ records the presence of "generally rather thin-bedded Devonian limestones" here. Aside from these few very general reports, the Devonian rocks in the Santa Catalina Mountains have not been discussed, and they have never been studied in detail.

The Devonian formations occupy a medial position, resting, with apparent conformity, on a buff to purple, sandy limestone of Cambrian age, and overlain, with apparent conformity, by the massive, gray Mississippian limestone. The formations total, approximately, three hundred feet in thickness, and are divisible lithologically into three distinct units:

¹³Stoyanow, A.A., Notes on Recent Stratigraphic Work in Arizona: Amer. Jour. of Science, Vol. XII, p. 320, Oct., 1926.

¹⁴Ransome, F.L., U.S. Geol. Survey, Geol. Atlas, Ray Folio 217, p. 8, 1923.

¹⁵McDougal, D. F., Botanical Features of North American Deserts: Publ. Carnegie Inst., pp. 45-49, 1909.

¹⁶Ransome, F. L., Some Paleozoic Sections in Arizona and their Correlation: U.S. Geol. Survey, Prof. Paper 98K, pp. 144-145, 1916.

	<u>feet</u>
3. Compact, buff limestone in beds, 1 to 2 feet thick containing some coarse-grained sandy lenses near the base.....	60
2. Variegated, buff, yellow and red to brown, fine-grained, compact sandstone that weathers to a soft surface. Thick-bedded.....	90
e. Gray, compact limestone, beds 1 to 3 feet thick..	105
d. Pink sandstone and limestone.....	9
1 c. Gray, sandy limestone.....	3
b. Red sandstone and quartzite, weathers to a soft surface.....	22
a. Gray, compact limestone, beds 1-1½ feet thick; flaggy lamination toward the top.....	6
	295

Purple to buff, Cambrian limestone

Well-preserved fossils are very evident in the basal member of the lower group, but they are not abundant. Atrypa reticularis Linn., Schizophoria striatula, Zaphrentis sp., and Colonial corals have been observed here. The two overlying members are apparently unfossiliferous, but in the sandstone layers of the next member (d) many imprints of brachiopods are found, and Stropheodonta perplana (Conrad), as well as Schuchertella chemungensis (Conrad) has been found here. Well-preserved, silicified fossils are found throughout the thickness of the limestone forming the top of the group, but about half way from the top there is a horizon that is crowded with small brachiopod shells to such an extent that it might be termed a Coquina, with the grey limestone forming the cementing material. Atrypa reticularis is the predominant brachiopod in this thin horizon, but Spirifer hungerfordi and Sp. orestes are also found here. Overlying this bed, about fifteen feet

from the top of the member is a horizon, about ten feet thick, of coral reef aspect. It is composed, mainly, of Acervularia davidsoni E&H, A. profunda Hall, Pachyphyllum woodmani (White), Crepidophyllum sp., Cladopora prolifica H&W, and many other undetermined forms. These forms assume a very intimate assemblage included in which are many shells of Atrypa reticularis and other small brachiopods.

It is very evident from the preceding columnar section that this basal group does not conform to the lithological definition of the Martin limestone of the Bisbee section, but it is seen from the above list of fossils that its fauna agrees very closely with the Martin fauna. Faunally, therefore, group 1 of this section can be regarded as the equivalent of Martin limestone.

Examination of the thick sandstone formation overlying the group containing the Martin fauna has revealed the presence of another very interesting fauna. Fragmental fish remains, very poorly preserved, although retaining evidence of former structure in places have been collected, widely separated, throughout the formation. Aside from this scanty fish fauna, the sandstone seems to be entirely deplete of fossil remains.

The fish fauna continues into the overlying buff limestone, and in the lower, somewhat sandy and argillaceous portion of it there is a horizon about six feet thick that contains numerous fragmentary remains. Badly weathered material

exhibiting in places well defined structure and assuming a plate-like form is found throughout much of the buff limestone. In this fairly well defined horizon a perfect tooth of Cladodus sp. was found, its characters indicating lower Mississippian affinities. A specimen of coral, Favosites sp., and several tiny gastropods were also found in this lower part.

In addition to the horizon of very abundant fragmentary fish remains in the lower part of the buff limestone, there is another fossiliferous horizon very near the upper limit of the formation. Fragmentary brachiopod shells are fairly abundant in places, and a well defined, unmistakable portion of the ventral valve of Camarotoechia endlichi (Meek) was found here.

On the basis of the continuation of the fish fauna upward from the variegated sandstone, through the sandy phase of the overlying limestone into the buff limestone above, these two formations have been placed in a single group. In order to delimit this group from the underlying formations, so different faunally and lithologically, the name Santa Catalina Group will be applied to them.

SECTION V -- GLOBE

Devonian rocks are exposed in many places in the vicinity of Globe. They rest, evidently disconformably, on the Apache group, and are overlain conformably by the Mississippian limestones. The Devonian formations have been considered as a whole the equivalent of the Martin limestone of Bisbee, and F. L. Ransome says,¹⁷

"As the Devonian portion of the Globe limestone, as mapped in the Globe quadrangle, is continuous and identical with what is now named the Martin limestone, fossils collected from it should be included in the Martin fauna."

Following is the list of the fossils collected by Ransome in the Globe Quadrangle:¹⁸

Cf. Sponge
Cf. Rhodocrinus, crinoid stems and plates
Atrypa reticularis Linnaeus
Productella hallana Walcott
Stropheodonta calvini Miller
Cyrtia cyrtinaformis (H&W)
Spirifer hungerfordi Hall
Sp. orestes H&W
Sp. whitneyi Hall
Reticularia fimbriata (Conrad)
Cyrtina hamiltonensis Hall
Martinia subumbona (Hall)
Pugnax pugnax (Martin)
Schuchertella chemungensis (Conrad) var.
Dielasma cf. calvini (H&W)

¹⁷Ransome, F.L., U.S.Geol.Survey Geol. Atlas, Ray Folio 217, p. 8, 1923.

¹⁸Ransome, F.L., Geol. of the Globe Copper District, Ariz.: U.S.Geol.Survey Prof.Paper 12, pp. 39-81, 1901.

The general section of the Devonian formations, from which four of the lots from which the above forms were determined, were collected as exposed on Pinal Creek three and three-quarters miles from the Old Dominion mine, is as follows:

	Gray fossiliferous Miss. limestone	
6.	Buff, argillaceous limestone	18 feet
5.	Yellow, papery shales	36 feet
4.	Yellow, rusty, compact limestone, rather thin-bedded, with crinoidal layer near the top.	
3.	Yellow, cross-bedded, fine-grained sandstone, underlain by two to three feet of shale	
2.	Gray, cross-bedded, fine to coarse, calcareous sandstone	
1.	White to gray, massive limestone	
		<hr/>
		325 feet (approx.)

A few miles north of this locality, on the west side of the Apache Trail another section of Devonian strata is well exposed. Here the basal member is seen, resting on a quartzite of the Apache group, consisting of about thirty feet of siliceous breccia containing many large angular fragments of quartzite. About midway in the section a thin layer of yellow, fine-grained sandstone is found, containing impressions of the corals Acervularia davidsoni E&H, and Pachyphyllum woodmani (White). The remainder of the section is identical with the section on Pinal Creek.

In the Devonian formations represented by the two foregoing sections, there are clearly two and possibly

three faunas represented. The fauna collected by Ransome has been found by the writer to be confined to the limestones designated "4" in the section on Pinal Creek, limited by the yellow sandstone at the base, and by the papery shales at the top. The following additional forms have been found

Acervularia davidsoni E&H
Pachyphyllum woodmani (White)
Delthyris consobrinus (d(Orb)
Spirifer suborestes Webster
Zaphrentis (?) sp.
Sp. robustus Webster

The upper limestone beds are fairly crowded with Atrypa reticularis, Productella hallana, and other small forms.

With the change from limestone to the overlying shale the tremendously abundant number of forms disappear, and the shale appears to be absolutely depleted of organic remains. If it was not for the fact that some shaley layers of the limestone contain numerous fossils, the change in the type of sediment might account for the paucity of forms. Very, very slight suggestion of the appearance of a new fauna is seen in the shale, but it is not until the overlying, very argillaceous limestone is reached that it assumes a definite form. In this limestone, in the section near the Old Dominion mine, two well-defined fish teeth have been found, and determined as two distinct species of the genus Orodus. Other evidence of fossil remains of fish is fairly abundant, but decidedly ill-defined. Fragmentary shells of brachiopods are

also found in this limestone, and in the same formation in the section a few miles north, a perfect specimen of Camarotechia Endlichi (Meek) was found.

The writer believes that these facts are sufficiently strong to allow the establishment of the formation containing these forms as a definite faunal unit, and that the shale and limestone members can be regarded as single lithological units on the basis of the argillaceous character of both. Thus defined as a faunal and lithological unit these formations are regarded as the equivalent of the Santa Catalina group of the Peppersauce Canyon section.

In the bed of the yellow cross-bedded sandstone that underlies the limestones containing the Martin fauna, a single fragment of a fish tooth was found. Its structure indicates that it is, unquestionably, a fragment of a tooth of Ptyctodus sp.

CHAPTER II

CORRELATION AND DISCUSSION

As the Martin limestone, a formational unit, is represented as containing the expression of the Hackberry fauna (Lime Creek) of Iowa, particularly in its upper half, any Devonian strata in Arizona containing this faunal expression should be considered the faunal equivalent of the Martin limestone. On this consideration the following correlations will be based.

It is very evident from the foregoing columnar sections that the Devonian strata at Reese Camp, and in the Patagonia Mountains, represent faunally and lithologically the equivalent of the Martin limestone. Composed of moderately thin-bedded grey limestones throughout, these sections yield forms typical of the Martin limestone at Bisbee.

In the Picacho de Calera Devonian section a great departure from the typical Martin is noticed. Separated from the underlying Abrigo limestone by a thin bed of calcareous sandstone, the Devonian section consists of forty feet of moderately thin-bedded, blue gray limestones, containing an interesting Coral and Algae fauna. Separating these limestone beds from an overlying grey limestone containing typical forms of the Hackberry fauna, is a thin bed of calcareous sandstone yielding an important fish fauna. The overlying limestones

are in turn overlain by approximately one hundred seventy feet of calcareous sandstone and grey limestone which will be provisionally regarded as equivalent to the Santa Catalina group of the Peppersauce section. The grey limestone, immediately overlying the fish bed, containing forms typical of the Hackberry fauna, must be regarded, faunally, as the equivalent of the Martin limestone. The thin fish bed is evidenced at Globe where it is also overlain by limestones yielding typical Hackberry forms. The Coral and Cryptozoan, and the fish fauna, although not typical of the Hackberry fauna and not described from the Martin limestone, occupy, nevertheless, a position stratigraphically equivalent to the lower portion of the Martin formation as such; that is, both the faunas underlie the portion of the section yielding typical forms, and overly the Abrigo limestone. These facts, that the non-typical lithographic and faunal units are overlain by strata containing typical Martin forms, and that these lithographic and faunal units occupy a stratigraphic position equivalent to the non-fossiliferous, lower half of the Martin limestone, indicate that these units are depositional and faunal facies of a deposition equivalent to the Martin limestone.

In the section at Peppersauce Canyon, the lower part of the section, overlain by the fine-grained, yellow sandstone of the Santa Catalina group, contains throughout an expression of the Hackberry fauna of the Martin limestone; and

the coral reef like horizon, so well defined at both the Patagonia and Reese Camp sections, is very evident here. Lithologically, however, this lower portion is not the equivalent of the Martin limestone, and it differs both lithologically and faunally from the Martin expression at Picacho de Calera. On the grounds of the presence of the Santa Catalina group overlying the strata containing the Martin fauna, in both localities, the Peppersauce Canyon section can be satisfactorily correlated with the Globe section.

Underlying the sandstone containing evidence of a fish fauna identical to that at Picacho de Calera, at Globe there is a considerable thickness of massive, unfossiliferous limestone, containing a great deal of siliceous, fragmentary material at the base, above the underlying quartzite of the Apache Group. This interformational material seems to be represented at Picacho by the thin bed of sandstone separating the Cambrian and Devonian limestones.

Possibly the very evident absence of the unfossiliferous, lower limestones, found in both the Globe and Ray¹⁹ sections, from the Peppersauce Canyon section can be explained on the assumption that the underlying combined thickness of the Apache Group and the Cambrian limestone and sandstones here appeared as a greater relief during deposition than did simply the underlying Apache Group in the other two sections.

¹⁹

Ransome, F.L., U.S.G.S. Geol. Atlas, Ray Folio, 217, p.7, 1923.

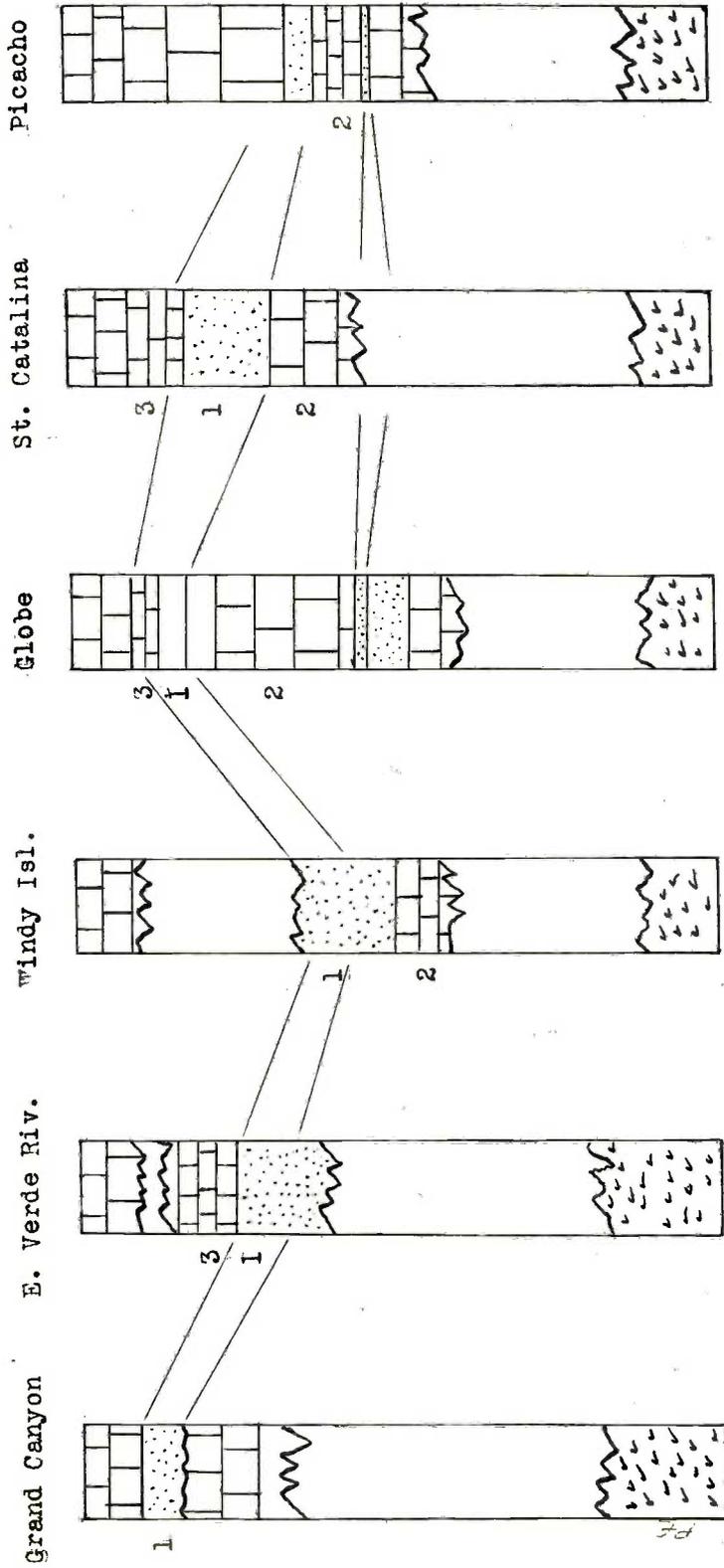
The northwest thinning of the Martin equivalent is very evident from a study of the relative thicknesses of the Devonian sections. In the Patagonia and Reese Camp sections there is a noticeable diminution of the 340 feet of strata of the type section at Bisbee, and at Picacho de Calera a maximum of 150 feet of sediments can be regarded as equivalent of the Martin. The 150 feet of strata carrying Martin forms at Peppersauce Canyon compared to the maximum of 250 feet at Globe, farther north, indicates the variability of the surface of deposition, and the 300 feet of Devonian rocks at Roosevelt, a part of which at least carry a fauna distinct from the Hackberry fauna,²⁰ shows the continued thinning of the Martin northward, until at East Verde River crossing the strata carrying fossils of the Martin formation are entirely missing.

However unsatisfactory the above correlations may be it is nevertheless evident that the Martin limestone as such is very restricted, and that its equivalent thins out to the northwest, accompanied by a decided inconstancy of deposition.

²⁰Ransome, F.L., U.S.G.S. Prof. Paper 98K, Some Paleozoic sections in Arizona and their correlation, p. 151-152, 1916.

DISTRIBUTION AND RELATION OF DEVONIAN FISH HORIZONS
OF ARIZONA.

Column only relative.



The accompanying columnar sections, the first three of which were prepared from the literature, and the remaining three from the writer's observations, represent only the relation of the fish-bearing horizons to other formations with distinctive fauna.

Legend

1. Fish-bearing horizon.
2. Formations yielding typical Martin faunal elements.
3. Formations yielding typical lower Ouray faunal elements.

The first discovery of fossil fish made in the Devonian rocks of Arizona was made by C. D. Walcott in 1880, in the Grand Canyon region in the vicinity of Kanab Creek. Walcott says of the locality:²¹

"The Devonian beds are very variable in character and of little vertical range. At their greatest development, when increased by being deposited in a hollow of the limestone beneath, there is but 100 feet of purple and cream colored limestone and sandstone passing into gray calciferous sandstone above. Over the knolls of Silurian (Cambrian) limestone the upper beds alone extend with a thickness of from 10 to 30 feet. The purple sandstone deposited in the hollows of the Silurian limestone are characterized by the presence of Placoganoid fishes of a Devonian type."

Several years later Noble²² found fish remains in a pocket of the Temple Butte limestone in Sapphire Canyon, about 12 miles west of El Tovar. Of the deposit in which they were found he says:

"It consists essentially of irregularly bedded calcareous sand rock whose component grains are chiefly calcareous or dolomitic sand: the rock might thus either be classified as a limestone or sandstone....Most of the rock is moderately fine-grained and nearly all of it exhibits cross-bedded structure."

Regarding the occurrence of the fossils he says:

".....The fossils occur in the lower part of the deposit, most of them within 3 feet of the base. They are abundant but fragmentary and poorly preserved."

J. W. Gidley determined the fragments as belonging to Bothriolepsis, a genus characteristic of the Upper Devonian.

²¹Walcott, C.D., Pre-Carboniferous Strata in the Grand Canyon of the Colorado, Ariz: Amer.Jour. of Science, Vol. 26 (3), p. 438, 1883.

²²Noble, L.F., U.S. Geol. Survey, Prof. Paper 131b, p. 52, 1922.

In the summer of 1925, Dr. A. A. Stoyanow,²³ while working in the vicinity of the East Verde River crossing north of Payson, Ariz., discovered a sandstone which in the upper part was "replete with dermal plates of Arthrodira," belonging to the genus Macropetalichthys. The sandstone in which the discovery was made has a thickness of 125 feet, resting on the pre-Cambrian granite and overlain by approximately 350 feet of thin-bedded gray limestone.²⁴ Prof. Schuchert and Prof. Stoyanow²⁵ have found Spirifer whitneyivar animasensis Girty and Atrypa reticularis Linn. in this overlying limestone, and higher in the section they collected Pachyphyllum woodmani (White), Acervularia davidsoni (E&H) and Cladopora prolifica (H&W). Dr. Stoyanow has also reported,²⁶ from Windy Hill on the western shore of Roosevelt Lake, a red sandstone containing fish plates, underlain by a "yellow, arenaceous limestone with Spirifer eurytienes Owen, and Atrypa reticularis Linn."

The writer while examining a Devonian exposure near Globe, Ariz., discovered evidence of a fish fauna there. In a formation grading from a yellow, papery shale at the base, to an argillaceous, buff limestone at the top, of an aggregate thickness of 50 to 60 feet, two indeterminable species

²³ Stoyanow, A.A., Recent Stratigraphic Work in Arizona, Am. Jr. of Science, Vol. XII, Oct., 1926, p. 313.

²⁴ Ransome, F.L., Some Paleozoic Sections in Arizona and their Correlation: U.S. Geol. Survey, Prof. Paper 98K, pp. 159-60, 1916.

²⁵ Stoyanow, A.A., op. cit., p. 312.

²⁶ Stoyanow, A.A., op. cit., p. 315.

of the genus Orodus were found. The argillaceous formation is underlain by a considerable thickness of moderately thin-bedded, yellow to gray, compact limestone replete with fossils of the Martin fauna, and from a nearby section, in the buff limestone corresponding to the upper part of the argillaceous formation here, a perfect specimen of Camarotechia endlichi (Meek) was found.

Many miles south of Globe, in the Santa Catalina Mountains near Tucson, evidence of a fish fauna with relations very similar to those of the fish horizon at Globe, was found. Here, overlying a moderately thin-bedded group of sandstones and limestones containing characteristic Martin fossils, is a thick-bedded, fine-grained, red to yellow, calcareous sandstone about 100 feet thick, containing obscure traces of fish remains. Overlying this sandstone there is about 60 feet of compact, buff limestone, near the base of which is a horizon replete with poorly preserved fragments of fish remains. In this horizon a perfect specimen of a tooth of Cladodus sp. was found. Here, as at Globe, this upper buff limestone contains well-defined fragments of Camarotechia endlichi (Meek).

Difficulty is encountered in the correlation of these widely separated fossil fish localities in that the forms collected from the various places are neither generically nor specifically related. Ostracophores (Bothriolepsis), Arthrodiros (Macropetalichthys) and Elasmobranchs (Cladodus

an Orodus) comprise the fauna collected from these various localities. It may be significant, however, that although *Macropetalichthys* is known from formations older than the Upper Devonian, *Bothriolepsis* is exclusively an upper Devonian genus, and the specimens of *Cladodus* and *Orodus* found show very close affinities to lower Carboniferous forms.

Correlation, then, must be made on other grounds than faunal characteristics. It seems significant to the writer that the fish horizon studied by Dr. Stoyanow at East Verde crossing, resting on Pre Cambrian granite or possibly Cambrian sediments²⁷ is overlain by limestones from which *Spirifer whitneyi* var *animasensis* Girty, a form typical of the fauna of the Lower Ouray limestone of Colorado, was collected.²⁸ In the Windy Hill section the investigator found that the sandstone containing the fish remains was underlain by a limestone containing the well-known form, *Spirifer eurytienes* Owen, of the fauna of the Martin limestone. This fact has little significance, however, until it is remembered that at both the section at Globe and at the section in Peppersauce Canyon in the Santa Catalina Mountains, the formation containing the fish remains is underlain by limestones containing typical Martin fauna, and is overlain by or continuous with limestone

²⁷ Stoyanow, A.A. op. cit., p. 313.

²⁸ Kindle, E.M., The Devonian Fauna of the Ouray Limestone:
U.S.G.S.Bull. 391, 1909.

that in both sections yielded well-defined specimens of Camaro-
techia endlichi (Meek), another very characteristic form of
the fauna of the Lower Ouray limestone. Thus we have as a basis
of correlation the facts that, in three sections the formation
containing the fish remains is overlain by or continuous with
limestones yielding fossils typical of the fauna of the Lower
Ouray limestone of Colorado, and that in three of the sections
the formation under discussion is underlain by limestones yield-
ing typical Martin fossils. On these grounds it seems reasonable
to regard the fish horizons found in the mentioned localities
as local expressions of a continuous shallow water deposition,
succeeding the deposition of the Martin limestone and preceding
the deposition of the typical Ouray limestone.

Witman Cross²⁹ in studying the Ouray forma-
tion of Colorado discovered that between the Ignacio quartzite
(Camb) and the Ouray limestone there are strata that "at the
base and also near the top" carry fish remains and that "seem
unquestionably to form a lithologic, stratigraphic and faunal
unit," and for which he has proposed the name of the Elbert
formation. Dr Eastman³⁰ determined material collected from
this formation as of the forms Bothriolepsis coloradensis East-
man and Holoptychius giganteus Agassiz. Spurr³¹ has pointed

²⁹Cross, W., A New Devonian Formation in Colorado: Amer. Jour.
of Science (4), Vol. 18, p. 249, 1904.

³⁰Eastman, C.R., On Upper Dev. Fish Remains from Colorado: Amer.
Jour. of Science (4), Vol. 18, pp. 253-260, 1904.

³¹Spurr, Q.E., Geology of the Aspen Mining District, Colorado:
U.S. Geol. Survey, Man. XXXI, pp. 13-22, 1898.

out the resemblance of a fish horizon near Aspen, Colorado, to the horizon observed by Walcott in the Kanab Valley in the Grand Canyon.

It appears very likely from the above that the fish horizon represented as extending south from the Grand Canyon to the Santa Catalina Mountains is the equivalent of the Elbert formation of Colorado. Should Spencer's³² suggestion that the lower part of the Redwall limestone (Miss.) of the Grand Canyon section is the equivalent of the Devonian of Colorado, be substantiated, this correlation would have a much more sound basis.

The fish bed discovered at Picacho de Calera Hills, which will be referred to as the Picacho sandstone, clearly is of very different stratigraphic relations than the fish horizon represented in the Peppersauce Canyon section.

Of the fragmentary remains very profusely scattered through the Picacho sandstone, three genera, Ptyctodus, Lambodus, and Cladodus have been recognized. Ptyctodus aff. Calceolus Newberry comprises the bulk of the remains.

Overlying the sandstone is a considerable thickness of limestone containing numerous representatives of the fauna of the Martin limestone.

There is a slight expression of the presence of this very interesting fish fauna in the Globe section also.

³²Spencer, H.W., Dev. Strata in Colorado: Amer. Jour. of Science (4), Vol. 9, p. 133, 1900.

In the sandy portion about midway in the section a single small fragment of fish remains was found, its structure indicating it to be of the same genus as the bulk of material from the Picacho sandstone. Singularly enough, the sandstone at Globe is overlain by limestone replete with typical Martin forms.

Particularly significant is the fact that from the limestone overlying the fish horizon in both sections, Spirifer robustus Webster has been collected.

As before, the relationships of the fish-bearing formation seems to suggest a correlation. Overlain at both Picacho de Calera and Globe by limestone containing forms specifically identical, the sandstone at Globe is underlain by massive limestone, apparently unfossiliferous, while at Picacho de Calera it is underlain by a thickbedded limestone containing an extensive Algae and Coral fauna.

While correlation on these grounds is not entirely satisfactory, it seems very probable that the fish-bearing horizon in the two localities represents an expression of the same depositional moment.

Thus established, in relation to definite Devonian formations of Arizona, the Picacho sandstone is possibly the expression of a much removed faunal equivalent. Samuel Calvin, in a description of the State Quarry limestone, in Johnson County, Iowa,³³ which immediately overlies the Cedar

³³

Iowa Geol. Survey, Vol. VII, 1896, pp. 72-79.

Valley, records a very interesting fish fauna. Speaking of the fish horizon of the State Quarry limestone he says:

"Whatever its position (in the State Quarry limestone, it is a bed of remarkable interest, for it is in places crowded with fish teeth that lie embedded in the chert or among triturated brachiopod shells in the calcareous portions of the bed. ..Several genera and species are indicated among the profusion of fish remains interred in this old cemetery. One of the most common forms is the well known Devonian type Ptyctodus. Teeth of this genus are sometimes literally crowded together to form sort of a fish tooth conglomerate...in the opinion of the experts to whom they have been submitted they (the teeth) probably belong to the single species Ptyctodus calceolus N&W".³⁴

At first the State Quarry limestone was considered as a local deposit made contemporaneously with the Cedar Valley limestone, but later investigations indicated that it was younger, and laid down on the deeply eroded surface of that limestone.³⁵

J. A. Udden, in a report of the geology of Muscatine County, Iowa,³⁶ has described some beds, which he has called the Sweetland Creek beds, that are found overlying the Cedar Valley limestone. The basal of these beds is a thin layer of stony material, about 4 inches thick, that contains specimens of Ptyctodus calceolus N&W and small teeth of other fishes. At many places under this lowermost layer the uneven surface of the top of the Cedar Valley limestone is seen.

³⁴Eastman, C R., Fossil Fishes of the Dev. of Iowa: Iowa Geol. Survey, Vol. VII, p. 108, 1896

³⁵Calvin, Sam., op. cit., p. 103.

³⁶Udden, J.A., Geol. of Muscatine County: Iowa Geol. Survey, Vol. IX, p. 289, 1898.

Inasmuch as these two formations rest directly on the uneven surface of the Cedar Valley limestone, and as the Lime Creek shales³⁷ or the Hackberry Stage³⁸ also rests on the Cedar Valley limestone in places, and as neither of these two fish horizons are found anywhere above the Hackberry, it seems that the Sweetland Creek beds and the State Quarry limestone occupy a position stratigraphically above the Cedar Valley limestone and below the beds of the Hackberry Stage.

With the above in mind some significance may be attached to the fact that the fish horizon at Globe is overlain by limestones containing the Martin fauna, which fauna according to H. S. Williams³⁹ contains forms typical of the Lime Creek shales (Hackberry); and to the fact that from the limestone overlying the fish bed at Picacho de Calera such forms as Spirifer robustus Webster and Spirifer suborestes Webster, typical of the fauna of the Hackberry Stage, were collected.

Of great interest is the appearance of the fauna of the Lower Ouray limestone in Arizona. Hitherto recognized only in three instances, first by F. L. Ransome⁴⁰, then

³⁷Calvin, Sam., op. cit., p. 161.

³⁸Fenton, M.A. and C.L., op. cit., pp. 1-7.

³⁹Ransome, F.L., U.S. Geol. Survey, Geol. Atlas., Ray Folio 217, p. 8, 1923.

⁴⁰Idem. p. 8.

by N. H. Darton,⁴¹ and again by A. A. Stoyanow,⁴² the relationships and distribution of this fauna in Arizona has not been discussed. The localities where the faunal elements of the Ouray Devonian have been found and the relations of the containing formation, have been presented in the preceding pages of this chapter so it will suffice here to remark only on the general bearing of the recognition of the lower Ouray fauna here on the Ouray problem.

After studying carefully all of the faunal elements of the Lower Ouray limestone, Girty says:⁴³

"I am led to conclude....that the Ouray limestone was deposited certainly no earlier than middle Devonian time, and that its deposition may have taken place as late as early upper Devonian time."

The relationships, both stratigraphically and faunally, of the formation containing the representative of the Ouray fauna in Arizona, shed a light on the consideration of the age of the typical lower Ouray fauna. The formation characterized by Camarotechia endlichi (Meek), in the Globe and Peppersauce Canyon sections, was found to overly the limestones containing fossils typical of the Martin limestone. Dr. Kindle⁴⁴ says of the Martin fauna:

⁴¹Darton, N.H., op. cit., p. 62.

⁴²Stoyanow, A.A., op. cit., p. 312.

⁴³Girty, G.H., The Fauna of the Ouray Limestone: U.S.Geol. Survey, 20th Annual Report, p. 36, 1898-1899.

⁴⁴Ransome, F L., Some Paleozoic Sections in Arizona and their correlation: U.S.G.S., Prof. Paper, 98K, p. 142, 1916

"On the grounds of its close relationship to an upper Devonian fauna of Iowa....I would place the fauna of the Martin limestone in the Upper Devonian."

Prof. H. S. Williams⁴⁵ says of the fossils collected by F. L. Ransome from the Martin limestone at Globe:

"They constitute the typical species of the Lime Creek shales of Iowa....."

Spirifer robustus Web.⁴⁶ and Spirifer suborestes Web., forms typical of the Lime Creek shales, have been collected from the Martin limestone at Globe. According to C. L. and M. A. Fenton⁴⁷

"the Hackberry Stage (Lime Creek shales) represent the youngest Devonian known in the Mississippi Valley."

The position of the formation containing representatives of the Lower Ourayian fauna in regard to the strata yielding Martin fossils, and the fact that the fish teeth collected from the same formation show very close Carboniferous affinities, indicates that the Ouray fauna is of very late Devonian age.

Regarding the distribution of the Ouray fauna, E. M. Kindle⁴⁸ reports that it is restricted to Colorado and New Mexico, and that

"the fauna representing the Devonian of Arizona... is distinct from the Devonian fauna of the Ouray."

⁴⁵Ransome, F.L., U.S.Geol. Survey, Geo. Atlas, Ray Folio 217, p.8, 1916.

⁴⁶Univ. of Arizona Collection.

⁴⁷Fenton, M.A. and C.L., op. cit., p. 17.

⁴⁸Kindle, E.M., op.cit., p. 13.

The presence of the Ouray both in south central Arizona and in New Mexico suggests that the formation is more widespread over Arizona than is now realized.

In summing up the material presented in the preceding pages, the following conclusions are formed:

1. The representative of the Upper Devonian in central and southern Arizona consists of two distinct faunal units.
2. The oldest of these units, the Martin limestone, characterized as containing the expression of the Hackberry fauna of Iowa, is very restricted as a formation, but its faunal equivalent extends northwest across Arizona, thinning until in central Arizona it is entirely missing.
3. The youngest Devonian in Arizona, typified by the Santa Catalina group, and characterized as containing the expression of the fauna of the Elbert and Lower Ouray formations of Colorado. Equivalents of this group are known from northern to southern Arizona. The lithological character of the lower member and the stratigraphic position of the group indicates a widespread shallow water deposition succeeding the deposition of the Martin equivalent, and followed by as equally widespread deep water conditions.

CHAPTER III.

PALEONTOLOGICAL DESCRIPTIONS

In the following pages the fossils collected from the five Devonian sections studied will be listed, descriptions accompanying the forms hitherto not reported from the Devonian of southeastern Arizona.

VERTEGRATA

Order Holocephali

Family Ptyctodontidae

Genus Ptyctodus Pander 49

Oral surface triturating, the single tritoral area of each dental plate well differentiated and consisting of hard, punctate, super-imposed laminae composed of enamel tubes, and producing on the triturating surface a series of transverse furrows and ridges, arranged more or less obliquely to the functional surface. Lower dental plates with symphyseal beak which, as shown by marks of wear, closed against the outer margin of the upper dental plates. The teeth are of medium or large size, elongated in form, with an expanded, sub-conical base and a flattened dental crown. In form and microscopic

49

- Ptyctodus Pander: N.Y.State Mus. Rept. No.10, p. 70, 1906.
do Geol.Surv. of Ill., Paleontology, Vol.II
p. 106, 1886.
do U.S.G.S. Prof.Paper 16, 1899.

structure the teeth of *Ptyctodus* differ so widely from any living or fossil form that it is scarcely possible to offer any conjecture as to their affinities. All of the teeth of *Ptyctodus* show some thing of the peculiar transverse striation of the flattened crown that constitutes the distinctive feature of the genus.

Ptyctodus aff. *calceolus* N&W ⁵⁰

The material at hand is undoubtedly of the genus *Ptyctodus*. It is very fragmentary and suggests depositional wear, but on some of the better preserved fragments the distinctive characters of the genus can be observed. The transverse furrows and ridges formed by the transverse arrangement of enamel tubes are well seen even on the smallest fragments. Many specimens suggest clearly the elongated form, and one specimen shows the expanded, sub-conical base, and corresponds to some extent to Fig. 10-b, Plate X, Geological Survey of Illinois, Vol. II, Paleontology. No definite specific character can be recognized, but the general form and structure indicate a relationship of the fragmentary remains to *Ptyctodus calceolus* Newberry and Worthen. Locality: Sec.III (Picacho de Calera).

50

Eastman, C.R., Amer. Naturalist, Vol.XXXII, p. 476; Fig. 1-17, p. 477. 1898.

Eastman, C.R., Iowa Geol. Survey, Vol.VII, p.114, 1896.

Order Ichthyotomi

Family Platodontidae

Genus Cladodus Agassiz 51

This typically Carbonic genus occurs sparingly in the Neo-Devonian, but only two instances are known of its occurrence in the Meso-Devonian. The teeth are multicuspitate and are from minute to very large size.

Cladodus sp.

Tooth fairly robust, low in stature, of small size. Base slightly sinuate in front. Anterior-posterior angles moderately prominent, and thence broadly rounded to the lateral extremities which are also rounded or obtusely angular, and rounded behind.

Coronal cusps strong, sub-lenticular in transverse section, both faces presenting simple, strong, sharp costae; two on the outer pair of lateral denticles, two on the well developed medial pair of lateral denticles, and eight on the median cone. All cusps have sharp cutting edges.

Median cone strong and slightly recurved.

Base greatly extended posteriorly. Inferior surface well depressed with a well-defined lip being the continuation of the posterior-inferior angle. A well-defined

ridge skirts the base of the denticles beneath which the base is very porous. Posterior surface of the median cone marked with one excentric rib. Locality: Section IV (Peppersauce Canyon).

Cladodus sp. "b"

A small imperfect form with a small median cusp with a larger lateral denticle on either side. All denticles ornamented with strong, rounded costal, spirally curved about the larger denticles. Locality: Fish bed, Picacho de Calera Hill.

Genus Lambodus St. Johns-Worthen 52

Teeth small, base posteriorly produced, more or less laterally expanded, long, elliptical or sub-circular in outline broadest behind the cornua, slightly produced in front, gently concave or sometimes convex below. Superior surface convex. A strong, slightly sigmoidally curved, re-curved eccentric cornua rises from the anterior angle of the base, terminating in a sharp apex, compressed in front, broadly rounded behind, with a more or less distinct cutting edge and irregular vertical costae.

It is distinguished from *Cladodus* by the single coronal cusp, and the absence of lateral denticles.

The genus is, so far as known, restricted to lower Carboniferous formations.

Lambodus sp.

Tooth of small size, base laterally elliptical in outline. Anterior border slightly depressed, continuing with the curve of the cusp. Inferior border of base slightly produced with curve of the inferior surface of the cusp. Coronal cusp strong, gradually tapering to an acute apex, very slightly deflected laterally, and curved backwardly. Ovate section with fairly sharp cutting edges. Anterior face occupied by about thirty strong, rounded, bifurcating costae. Bifurcation takes place regularly about two-thirds of the height of the cusp, and continues toward the base. Sixteen costae are noticed near the apex.

The costae of the posterior surface are only partially preserved in the specimen at hand, but about fifteen strong rounded costae are seen, noticeably curved from the edge, where they join the costae of the anterior surface in a slightly pustulose ridge, toward the center.

Dimensions:	<u>inch</u>
Lateral diameter of the base.....	5/16
Antero-posterior dia. of base.....	1/8
Height of cone.....	1/4
Greatest diameter of base.....	5/32

The specimen described appears to be closely related to L. costatus St. J. & W. of the upper Burlington limestone of Iowa, and its affinities all seem to be with the lower Mississippian forms. However, the specimen is undoubtedly of Devonian age and its affinities suggest that it is of the youngest Devonian.

Locality: Section III (Picacho de Calera)

Order Asterospondyli

Family Cestraciontidae

Genus *Orodus* Agassiz 53

This genus is known only by obtuse, elongated teeth. The dental crown is raised in the middle, and its surface marked with more or less prominent wrinkles, which rise from each long margin or from a median longitudinal crest. Base of tooth very stout.

53 Geol. Survey of Ill., Vol. VI, p. 295.

Orodus sp. a.

The single tooth collected by the writer is not complete enough to allow specific description. It is of medium size, base moderately thick, more or less oblique to the crown, moderately excavated in the outer face. Posterior surface slightly arched in both direction, and was apparently coarsely roughened by plications obliterated by wear. Principal cone produced more as a swelling on the base rather than as a distinct denticle. Punctate structure of the tooth apparent.

The tooth at hand appears very close to O. variocostatus St. J. & W. of the upper Burlington limestone of Iowa. Lack of literature prohibits specific determination.

Locality: Section VI (Globe).

Orodus sp. b.

A large, very rudimentary tooth has been placed, provisionally in this genus. It has a large, robust base, without a well defined coronal elevation, showing slightly developed plications.

Locality: Section VI (Globe).

MOLLUSCOIDEA

Class BRACHIOPODA

Genus ATRYPA Dalman

Atrypa Reticularis Linn.

Atrypa reticularis, Hall. Pal. N.Y., IV, 1867, p. 316,
pl. 52, figs. 1-3, 7-12; pl. 53-A, figs. 22, 23.

Atrypa reticularis, Hall. Meek & Worthen, Geol. Surv.
Ill., III, 1868, p. 432, pl. 13, fig. 11.

This species occurs abundantly throughout
the Martin limestone in all the sections studied.

Genus CAMAROTOECHIA Hall & Clarke

Camarotoechia (Plethorhyncha) endlichi (Meek)

Rhynchonella endlichi Meek, Bull. U.S. Geol. & Geog. Survey
Terr., 2nd ser., No. 1, 1875, p. 46.

Camarotoechia endlichi, Girty, 2nd Ann. Rep. U.S. Geol. Survey,
Part II, 1902, p. 756, pl. 6, figs. 1-4. pl. 9, fig. 1.

Two specimens of this form were collected; one from the
Globe section and one from the Peppersauce Canyon section.
Representative of the Lower Ouray fauna of Colorado it is found
in these places in limestone overlying the beds of the Martin
equivalent.

Genus CYRTIA Dalman

Cyrtia cyrtinaeformis (H&W)

Cyrtia cyrtinaeformis, H&C., Pal. N.Y., VIII, Pt. II, 1893,
p. 42, pl. 25, figs. 26-32.

This form was collected by the writer from the Picacho de
Calera section, and is found generally throughout the Martin

limestone.

Genus DELTHYRIS Dalman

Delthyris consobrina (d'Orb.)

Spirifer consobrinus, H&C, Pal. N.Y., VIII, Pt. II, 1895,
pl. 34, fig. 9, 18; pl. 37, figs. 9-10.

A single specimen of this species was found in the Globe
section of the Martin limestone.

Genus PRODUCTELLA Hall

Productella hallana Walcott

Productella hallana, H&C, Pal. N.Y., VIII, Pt. I, 1892,
pl. 17A, figs. 11,12.

This form, typical of the Martin fauna, was collected
from the Picacho and Globe sections.

Genus SCHUCHERTELLA Girty

Schuchertella chemungensis (Conrad)

Orthotheses chemungensis, Girty, 20th Ann. Rept., U.S.
Geol. Survey, Pt. 2, 1900, p. 40, pl. III, figs. 1-2, 4-5.

Well preserved forms of this fossil are found in a sandstone
bed in the Martin equivalent at Peppersauce Canyon.

Genus SCHIZOPHORIA H&W

Schizophoria striatula (Schlotheim)

Schizophoria impressa, H&C, Pal. N.Y., VIII, Pt. 1, 1892,
p. 212, 216, pl. 6, figs. 31; pl. 6A, figs. 26,27.

This form was collected from the basal limestone in the
Peppersauce Canyon section.

Genus SPIRIFER Sowerby

Spirifer hungerfordi, Hall,

Spirifer hungerfordi, Hall, Geol. Iowa, Vol. I, Pt. 2, p. 501, pl. 4, fig. 1a-k, 1858.

Spirifer hungerfordi, H&C, Pal. N.Y., VIII, Pt. II, 1893, pp. 23, 25, 37, pl. 29, fig. 6.; pl. 37, figs. 26-30.

This form, typical of the Martin fauna, is found in all the sections studied except at Picacho de Calera.

Spirifer orestes H&W

Spirifer orestes, H&C., Pal. N.Y., VIII, Pt. II, 1893, pp. 27, 38, pl. 30, fig. 20.

Abundant specimens of this fossil are found in the Martin limestone of the Picacho de Calera section.

Spirifer robustus Webster

Spirifer robusta, Web. Contr. to the Paleontology of the Hackberry Group, p. 9, pl. 2, figs. 9-11, 1906.

This form is known both from the Globe and Picacho de Calera sections. The specimens from Picacho are rather large.

Spirifer suborestes Web.

Spirifera suborestes, Web. Contr. to the Paleontology of the Hackberry Group, p. 8, pl. 2, figs. 16-18, 1906.

This form is found also in both the Globe and Picacho de Calera sections.

Spirifer whitneyi Hall.

Spirifer whitneyi, Hall., Geol. Iowa, Vol. I, pt. 2, p. 502, pl. 4, fig. 2, 1858.

Spirifer whitneyi, H&C., Pal. N.Y., Vol. 8, pt. 2, pp. 24-37, pl. 30, figs. 18, 19, 1893.

This form is abundantly represented in the Picacho de Calera section, and is a typical form of the Martin fauna.

Spirifer sp.

A single specimen of this form was collected from the Greaterville section. It closely resembles *Sp. whitneyi* in outline, but the plications are rather coarse, numbering about 30 on the ventral valve. The plications on both the sinus and fold are strongly bifurcate.

Genus STROPHEODONTA Hall

Stropheodonta perplana (Conrad)

Stropheodonta perplana, Hall., Pal. N.Y., IV, 1867, p. 92, 98, pl. 11, fig. 22.

Stropheodonta (Leptostrophia) perplana, H&C, Pal. of N.Y., VIII, pt. 1, 1892, p. 288, pl. 18, figs. 2-13.

Numerous specimens of this form are found associated with *Schuchertella chemungensis* in the sandstone in the Martin equivalent at Peppersauce Canyon.

COELENTERATA

Class ANTHOZOA

Corals are abundant in all the Devonian sections studied, particularly in the Greaterville, Patagonia, and Peppersauce Canyon sections where a multitude of forms are found in the intimate assemblage of a coral reef. The study of this reef in the various localities where it is represented would be an

interesting problem, and would reveal, doubtlessly, many new species of corals.

The few following forms have been collected from the various Devonian sections studied:

Acervularia davidsoni E&H

Amplexus sp.

Cladopora prolifica (H&W)

Crepidophyllum sp.

Cyathophyllum sp.

Favosites sp.

Hallia (?) sp.

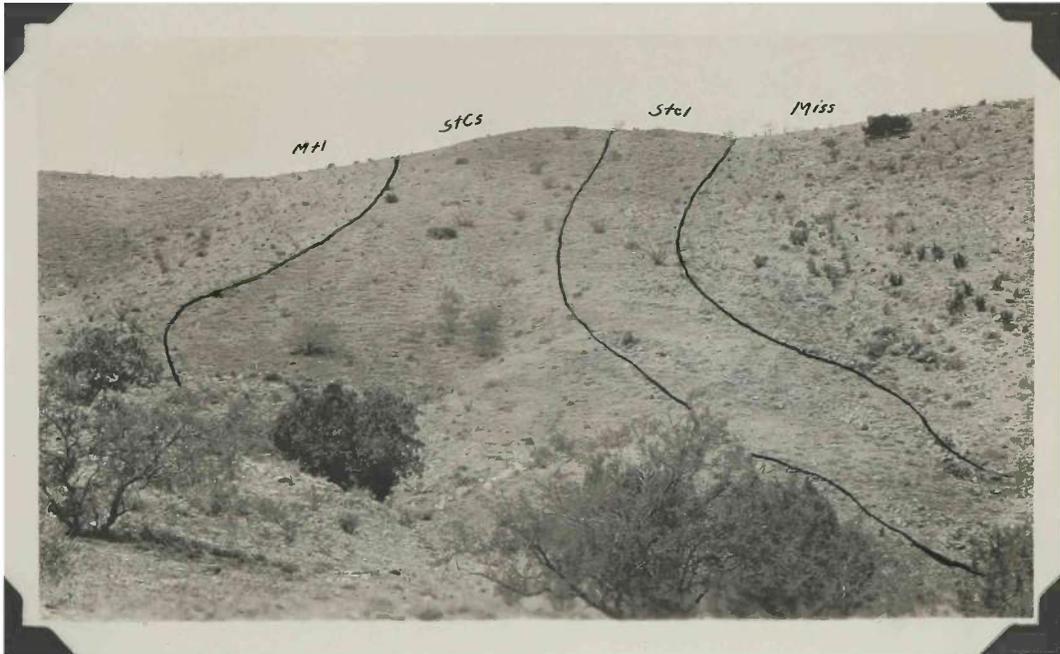
Pachyphyllum woodmani E&H

Tabulophyllum sp.

Zaphrentis sp.

PHOTOGRAPHS.

Plate III.



Santa Catalina Group, Peppersauce Canyon

Mt 1 = Martin limestone

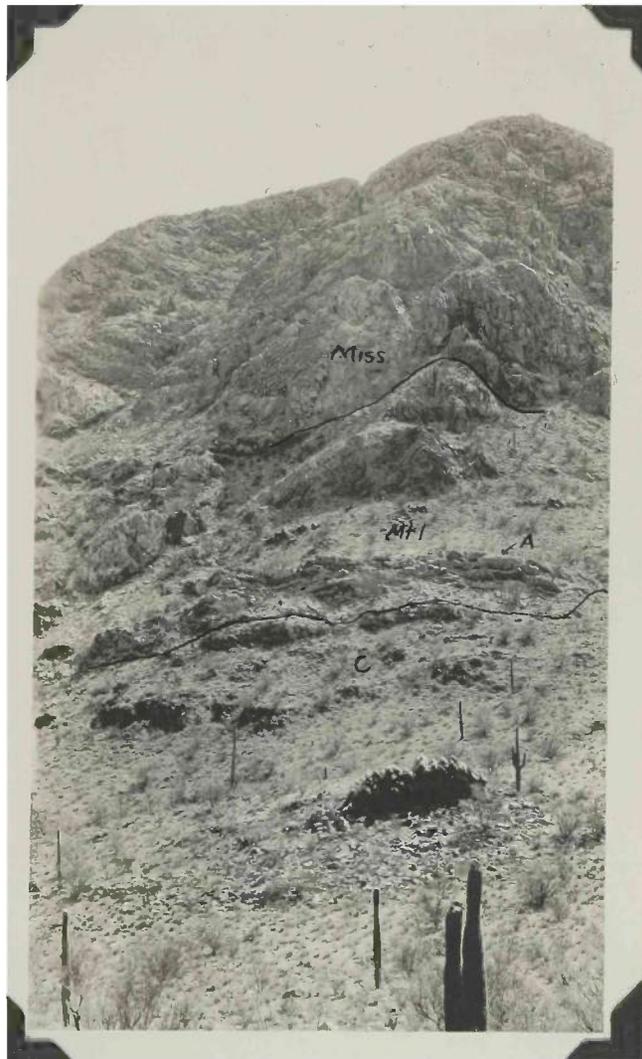
StC s = sandstone of St. Catalina Group

StC l = limestone " " " "

Plate III A



Picacho de Calera Hills.



Devonian Section, Picacho.

C= Cambrian limestone.
Mt 1= Martin limestone.
A= Fish Horizon.

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