THE THAYNES FORMATION, BEAR LAKE VALLEY, IDAHO.

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ABSTRACT. A complete detailed stratigraphic section of the Lower Triassic Thaynes formation is described from three outcrops in the Bear Lake Valley area, Idaho. Seven lithologic and faunal units are recognized and described. The subdivisions of the Thaynes formation described by Mansfield (1916) cannot be differentiated in the Bear Lake Valley. Subdivisions of the Thaynes formation herein described are correlated with units of the Thaynes in the Fort Douglas Military Reservation, Utah. Two new localities of the *Columbites* fauna are described.

INTRODUCTION.

THE Thaynes formation was described by Boutwell (1907) from outcrops in Thaynes Canyon, Park City Mining District, Utah. The section here is 1,190 feet thick and is composed of two limestone and siltstone units separated by a red shale member. The term Thaynes has subsequently been carried into southeastern Idaho and western Wyoming by Veatch (1907), Gale and Richards (1910), Schultz (1914), and Mansfield (1916). In southeastern Idaho and western Wyoming, the Thaynes formation as defined by these men included the strata from the base of the *Meekoceras* limestone up to the *Ankareh* shale. The name *Ankareh* has been replaced by the name *Timothy*, which includes the beds immediately overlying the Thaynes formation in southeastern Idaho (Mansfield, 1927, p. 84). The Thaynes formation was subdivided by Mansfield (1916) in the Fort Hall Indian Reservation into three members, the Ross Fork limestone, the Fort Hall limestone, and the Portneuf limestone. In this area the Thaynes formation consists of yellow, gray, silicious, and cherty limestones with some buff siltstone members and is estimated at 3,650 feet thick. Later Mansfield (1927) extended his terminology of the Thaynes formation into surrounding districts of southeastern Idaho. Mansfield's terminology of the Thaynes formation cannot be used in the Bear Lake Valley country. Rather than three, there are seven distinct faunal and lithologic units in the Thaynes formation as exposed in the Bear Lake Valley country. Each of these seven units is described and tentatively defined. Little is known as yet of the facies changes to the north and

northeast, and the Thaynes of the type locality has not yet been examined by the writer.

Stratigraphy.

Thaynes formation in the Bear Lake Valley.

Three sections of the Thaynes formation were studied in the mountains flanking the Bear Lake Valley, Montpelier quadrangle, Idaho. The Thaynes formation exposed in this region

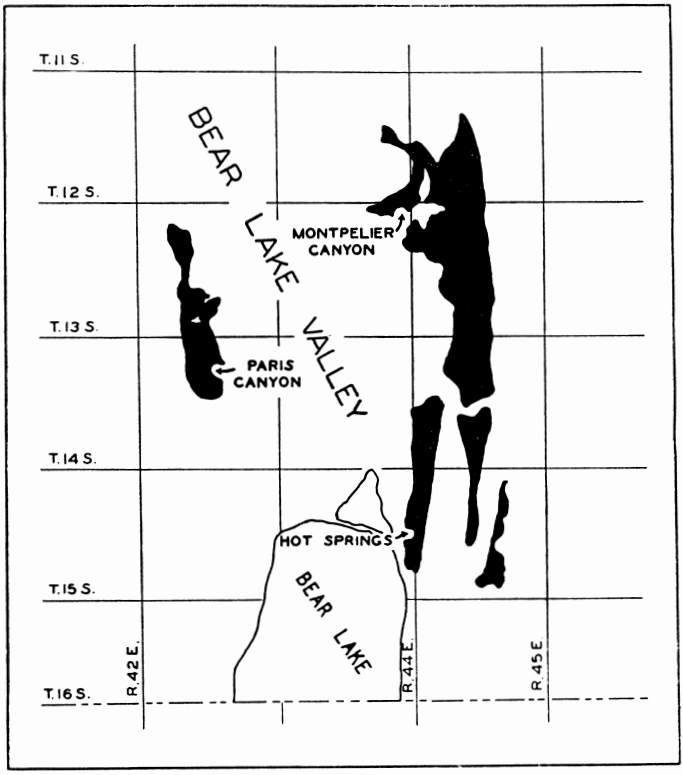

Fig. 1. Outcrop map of the Lower Triassic strata, Bear Lake Valley, Idaho.

consists dominantly of buff, massive to slabby siltstones; also there are silty limestones, massive, finely crystalline blue-gray to gray limestones, and buff silty to black bituminous shales. Near the top of the section there is a thick unit of red shale and siltstone.

The Thaynes formation exposed in its entirety was found only at Hot Springs, Idaho (Fig. 2). Here a complete section

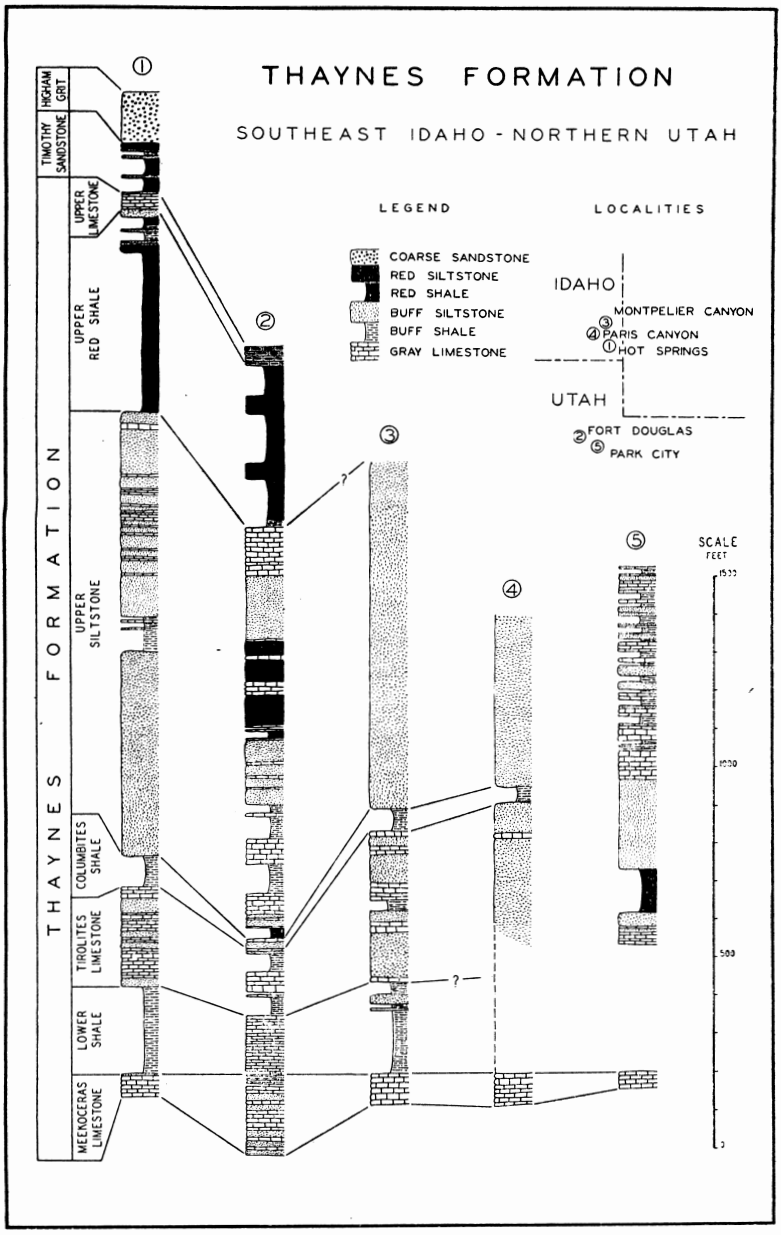

Fig. 2. Correlation of outcrop sections of the Thaynes formation in Bear Lake Valley, Idaho, and northern Utah: Section *1*, measured at Hot Springs, Bear Lake County, Idaho, W. ½ sec. 7, 18, T. 15 S., R. 45 E.; Section *3*, measured at Montpelier Canyon, Bear Lake County, Idaho, N. ½ sec. 2, T. 13 S., R. 44 E.; and Section *4*, measured in Paris Canyon, Bear Lake County, Idaho, NE. ¼ sec. 9, T. 14 S., R. 43 E., were studied by the author during the summer of 1941. Section *2* was measured by Mathews (1931, pp. 7-13) in the Fort Douglas area, Utah. Section *5* was measured by Boutwell (1912, pp. 55-56) from exposures of the Thaynes formation on the north side of Big Cottonwood Canyon, Park City mining district, Utah.

was measured in detail with the exception of a few relatively small covered intervals. Mansfield (1927) measured a section from the upper Thaynes formation to the Higham Grit in the Hot Springs locality.

The two other sections of the Thaynes formation studied in the Bear Lake Valley are exposed in Paris Canyon and in Montpelier Canyon (Fig. 2). At both of these localities the sections are incomplete; the top of the section was either covered, as in Paris Canyon, or cut off by the Madison limestone, as in Montpelier Canyon.

The topographic expression of the Thaynes formation is generally poor throughout southeastern Idaho. The typical Thaynes outcrop usually consists of smooth, grass-covered slopes, and talus slopes of flaggy buff siltstone and shale. Even the rather massive limestones form very low scarps and in many cases are completely covered except for a few thin beds.

The Lower Triassic section exposed at Hot Springs, Idaho, lies in the syncline of an overturned fold, the Permian Phosphoria formation lying above the Triassic Woodside and Thaynes formations. The strike of the beds is approximately N-S and the dip 65 degrees W. The structural attitude has resulted in excellent topographic expression of these relatively incompetent beds. Detailed examination of the Thaynes formation in the Hot Springs area reveals seven sedimentary units which are well-defined lithologically and faunally (Fig. 2). The units recognized within the Thaynes formation probably merit geographic names, but application of such names would at this time be premature. From bottom to the top of the Thaynes formation the units are as follows: (a) *Meekoceras* limestone, (b) lower shale, (c) *Tirolites* limestone, (d) *Columbites* shale, (e) upper siltstone, (f) upper red shale, and (g) upper limestone. These terms, as mentioned before, are only tentative designations and are used herein as a matter of convenience. With the exception of the *Meekoceras* limestone, the Thaynes units described are thus far only known at one or two localities.

Meekoceras limestone. The basal unit of the Thaynes formation is a grayish-blue to gray, massive limestone that weathers gray and contains abundant cephalopods of the *Meekoceras* type. In the Hot Springs section, the *Meekoceras* limestone is 52 feet thick and forms a prominent scarp for over two miles along the strike. This limestone is 81 feet thick in Montpelier

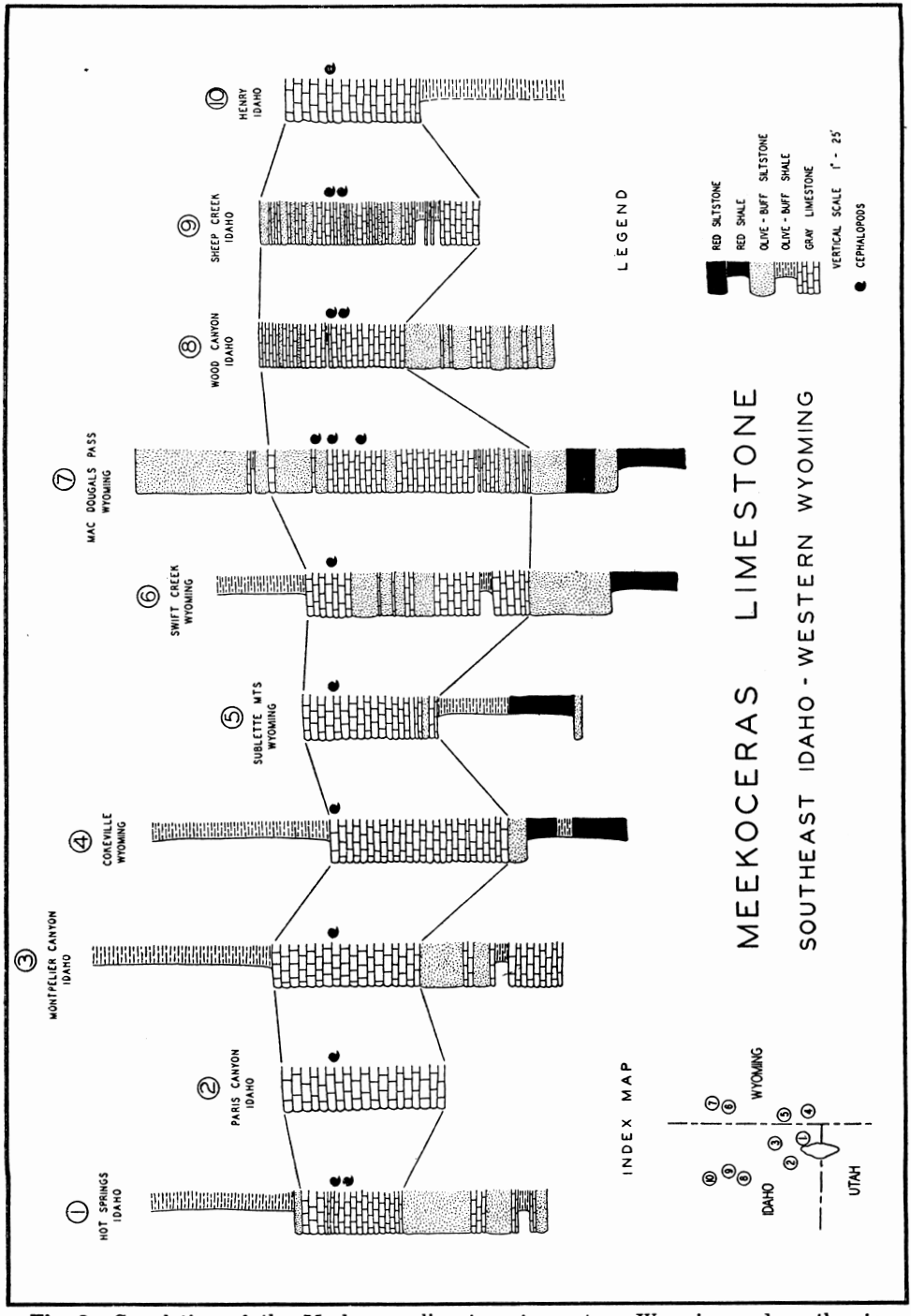

Fig. 3. Correlation of the *Meekoceras* limestone in western Wyoming and southeastern Idaho, illustrating the rather restricted occurrence of the *Meekoceras* fauna within the *Meekoceras* limestone. A facies change occurs within the *Meekoceras* limestone north and northeast of Bear Lake Valley, Idaho. The *Meekoceras* fauna has not been recorded from any locality in western Wyoming east of those indicated on the index map.

Canyon and 80 feet thick in Paris Canyon. In Paris Canyon, the *Meekoceras* limestone is poorly shown, consisting of residual talus blocks of limestone which contain a *Meekoceras* fauna. No accurate determination of the thickness could be made. In all three sections the limestone is apparently pure, with no intercalated siltstone or shale beds. The Montpelier Canyon section, however, reveals a few thin, silty limestones in the upper nine feet. At Cokeville, Wyoming, 18 miles east of Hot Springs, Idaho, the *Meekoceras* limestone is 100 feet thick and consists of massive, light-gray limestone. To the northeast of the Bear Lake Valley country, particularly at Sublette Canyon, Wyoming, Swift Creek Canyon, Wyoming, and at MacDougal's Pass, Wyoming, the *Meekoceras* limestone includes buff shale and siltstone units (Fig. 3). The quantity of fine clastics intercalated within the limestone increases to the northeast *and* east of Bear Lake Valley. At Sheep Creek, Grays Range, Idaho, and at Wood Canyon, Aspen Range, Idaho, the amount of clastics intercalated within the *Meekoceras* limestone is considerably less than at MacDougal's Pass, Wyoming, to the east. The *Meekoceras* limestone is not recognized north or east of MacDougal's Pass, Wyoming. There is a complete facies change from relatively a pure limestone unit to a mixed siltstone and shale unit. These clastics are buff colored southeast of MacDougal's Pass, as at North Piney Creek, Wyoming Range, Wyoming; northeast of MacDougal's Pass they are mainly red, as at Bear Gulch, Hoback Mountains, Wyoming, and at Gros Ventre Canyon, Gros Ventre Mountains, Wyoming. The environment of deposition in regions to the east of the line demarking the known easternmost extension of the *Meekoceras* fauna was probably unsuitable for the existence of cephalopods, for, as yet, no cephalopod shells have been found. This line demarking the easternmost extension of the known *Meekoceras* fauna might mark the eastern border of the marine invasion of the Lower Triassic geosyncline.

The distribution of the cephalopods within the *Meekoceras* limestone presents an interesting problem. At every locality studied, the *Meekoceras* fauna is confined to a 5-15 foot zone within the whole *Meekoceras* limestone. The remainder of the unit contains no cephalopods, but pelecypods and lingulas are present. This bed of cephalopods is confined to the upper third of the *Meekoceras* limestone in almost every case (Fig. 3).

Little detailed paleontological data are available, as yet, on most of these occurrences.

Lower shale. The interval between the *Meekoceras* limestone and the *Tirolites* limestone commonly is covered, but four partial exposures were studied in Montpelier Canyon, Idaho, Hot Springs, Idaho, Cokeville, Wyoming, and Georgetown Canyon, Idaho. The lower shale is an olive-gray to black, silty shale 200 to 250 feet thick. In the Montpelier Canyon section there is a 10-foot bed of light buff to pink shale near the top, overlain by a 15-foot zone of shaly siltstone. These two units were not observed at the other localities studied. At MacDougal's Pass, the interval above the *Meekoceras* limestone for 150 feet is composed of buff, massive siltstone with a few thin limestones; above this siltstone unit there is a 50-foot gray to black shale member with a red shale unit in the middle.

Fossils are rather scarce, but locally flattened impressions of cephalopods and pelecypods are abundant. It is suggested that this zone may be correlative with the *Anasibirites* zone of Fort Douglas, Utah.

Tirolites limestone. In the Hot Springs section the *Tirolites* limestone member forms the first scarp above the *Meekoceras* limestone. The unit is 200 to 385 feet thick and is composed of dark gray to blue and steel-gray finely crystalline limestones, massive to thin-bedded. In all the sections studied there are found several intercalated grayish-buff and dark blue calcareous siltstone units. In Montpelier Canyon the siltstones make up a large part of the member; here also, the unit has the greatest thickness so far measured. In Paris Canyon only a few thin limestones were observed, the section being composed predominantly of poorly exposed, gray to buff, calcareous siltstones. It is this member that contains the *Tirolites* fauna recorded by Smith (1932). A few *Tirolites* were found in Paris Canyon, but they are poorly preserved and rare. No cephalopods were found in the other outcrops studied.

The fauna of the *Tirolites* limestone is predominantly composed of brachiopods. Almost every limestone unit within this member contains myriads of brachiopods. Pelecypods and ossicles of *Pentacrinus* are also to be found. The cephalopod fauna is sparse and was found only at Paris Canyon, Idaho.

Columbites shale. At all three of the sections studied in the Bear Lake Valley country, a black shale member containing

abundant cephalopod-bearing concretions is present, overlying the *Tirolites* limestone and underlying the upper siltstone member. This member is 50 to 85 feet thick and is composed of black, silty, bituminous shale containing black limestone concretions. The concretions occur in three closely spaced horizons in the lower part of the member at Hot Springs and at Montpelier Canyon. In Paris Canyon this member is poorly exposed and the actual thickness and character of the member cannot be determined.

Smith (1932) records the *Columbites* fauna only in Paris Canyon, Idaho, lying "250 feet" above the *Meekoceras* limestone. He also refers to the *Columbites* bed as a "bituminous layer of brown limestone, not over 6 inches thick." It is easily understood from the exposures found in Paris Canyon why Smith had such an erroneous conception of the *Columbites* zone. Measurements of the interval from the *Meekoceras* limestone to the *Columbites* shale are 700 feet in Paris Canyon, rather than 250 feet as recorded by Smith (1932), 605 feet in Montpelier Canyon, and 483 feet at Hot Springs. At the Hot Springs locality, the dip of the *Columbites* shale is opposite to the dip of the members above and below. The slight irregularity of this shale member is probably due to minor folding within this incompetent member as the surrounding more competent members were folded and faulted in the development of the present structure.

The fauna of the *Columbites* shale is composed entirely of cephalopods and pelecypods. The concretions contain remarkably abundant well-preserved specimens, many concretions being coquinoid. The enclosing shales also contain the flattened impressions of cephalopods and pelecypods. This is the typical Columbitan fauna, the highest Scythian cephalopod horizon recognized in North America. Mathews (1931) has recognized the *Columbites* fauna in the Fort Douglas area, Utah. Thus the Fort Douglas outcrop and the three outcrops in the Bear Lake Valley country are the only places so far known where this fauna is found.

Upper siltstone. The upper unit consists of non-resistant, massive to slabby, gray to buff siltstone, which weathers buff to brownish-red. The only complete section was measured at Hot Springs, 1,145 feet being recorded. Throughout the whole siltstone section there are intercalated thin, silty, gray lime-

stones. These interbedded limestones contain a rather sparse brachiopod and pelecypod fauna. The siltstones contain casts and molds of small pelecypods, too poorly preserved to be identified. In Montpelier Canyon only 400 feet of the upper siltstone is present. The Bannock overthrust fault runs through Montpelier Canyon and the Madison limestone lies above the small portion of the upper siltstone exposed there. In Paris Canyon only a few hundred feet of the upper siltstone is exposed. In Slight Canyon, just one-half mile north of Paris Canyon, the contact between the *Columbites* shale and the upper siltstone members is exposed at the bottom of the canyon and 450 feet of slabby, buff siltstone is exposed above the *Columbites* shale. In Slight Canyon a flattened impression of an unidentifiable cephalopod was found 75 feet above the *Columbites* shale.

The upper siltstone is the most conspicuous member of the Thaynes formation in the Bear Lake Valley area. The great thickness, the homogeneous character of the sediments, and the prominent scarps formed by this member make its identification easy.

Upper red shale. This unit is a red-bed member 508 feet thick, exposed only at Hot Springs, Idaho. Lithologically, the upper red shale is composed of dark brick-red silty shales and siltstones; there are a few thin, green and gray shale and buff siltstone units near the top. This unit is the red-bed member of the Portneuf limestone described by Mansfield (1927, p. 88).

The dip of the upper red shale member at Hot Springs is opposite to that of the upper siltstone member. The contact between these two members is in the bottom of a narrow, shallow valley and is completely covered. The dip of the upper siltstone member is 60 degrees W.; that of the upper red shale member and the overlying beds is 66 degrees E. The whole Scythian section exposed at Hot Springs, Idaho, lies in the syncline of an overturned fold. The reverse in dip is apparently a product of folding rather than faulting.

Upper limestone. This member is the top unit of the Thaynes formation. Lithologically it consists of 67 feet of a massive, gray to blue, crystalline limestone which is cavernous in the lower part. The upper five feet is a massive, dark gray siltstone which weathers a greenish-buff and also contains some chert bands. This member was found exposed only at Hot

Springs, Idaho. The only fossils found were a few small brachiopods, difficult to collect.

This limestone is the equivalent of the thin upper Portneuf limestone of the Montpelier area as described by Mansfield (1927, p. 88).

Post-Thaynes Triassic.

Throughout southeastern Idaho, western Wyoming, and northern Utah there is a variable series of sedimentary rocks consisting of red shale, sandstones, and quartzites, yellow sandstones, and gray unfossiliferous limestones which lie above the Thaynes formation and below the Jurassic Nugget formation. In the Fort Hall Indian Reservation, Idaho, there are four formations that occupy this interval: the Timothy sandstone, the Higham Grit, the Deadman limestone, and, at the top, the Wood shale (Mansfield, 1927). These units thin out to the east and the southeast. In western Wyoming, 300 to 600 feet of red shales and siltstones lie between the Thaynes formation and the Nugget formation classed as Ankareh (Veatch, 1907; Schultz, 1920). In northern Utah there are 1,150 feet of red shales interbedded with coarse gray sandstones between the Thaynes and the Nugget formations (Boutwell, 1907; Mathews, 1931). The age and correlation of these strata have been a subject of controversy for 50 years. No fossils have been found in any of these formations and their lithologic facies makes correlation difficult. The Timothy sandstone and Higham Grit outcrop in the Hot Springs area, but the Deadman limestone and the Wood shale are too badly covered to be studied.

Thaynes Formation, Fort Douglas Military Reservation, Utah.

Mathews (1931, p. 7) recognized two distinct faunas, an upper and a lower Thaynes fauna. The fauna of the Pinecrest formation consists predominantly of cephalopods, representing the *Meekoceras*, *Anasibirites*, and *Columbites* zones, whereas that known from the Emigration formation consists predominantly of pelecypods with one cephalopod, identified as *Xenodiscus bittneri* Smith. Unfortunately the fauna of the Emigration formation has never been described or illustrated, and therefore Mathews' age determination cannot be checked from the literature.

A comparison of the Thaynes section at Hot Springs, Idaho, with that of the Fort Douglas section shows a close similarity (Fig. 2). In both sections the *Meekoceras* limestone is present at the base of the formation. That of the Fort Douglas area, however, contains several intercalated siltstone units. The

TABLE 1.

Triassic stratigraphy of southeastern Idaho and northern Utah as interpreted by Mathews (1931), Mansfield (1927), and the author.

	MATHEWS 1931 UTAH		MANSFIELD 1927 IDAHO		KUMMEL 1942 IDAHO	
JURASSIC	NUGGET		NUGGET		NUGGET	
UPPER TRIASSIC	ANKAREH					
MIDDLE TRIASSIC	THAYNES	EMIGRATION	?	WOOD	?	WOOD
				DEADMAN		DEADMAN
				HIGHAM		HIGHAM
LOWER TRIASSIC		PINECREST		TIMOTHY		TIMOTHY
			THAYNES	PORTNEUF	THAYNES	UPPER LIMESTONE
						UPPER RED SHALE
				FORT HALL		UPPER SILTSTONE
						COLUMBITES SH.
						TIROLITES LS.
				ROSS FORK		LOWER SHALE
						MEEKOCERAS LS.
	WOODSIDE		WOODSIDE		WOODSIDE	
					DINWOODY	
PERMIAN	PHOSPHORIA		PHOSPHORIA		PHOSPHORIA	

limestone member above the *Meekoceras* limestone in the Fort Douglas area contains the *Anasibirites* fauna. It is thought by the author that this member correlates with the lower shale of the Thaynes formation of the Bear Lake Valley country, Idaho. Flattened impressions of cephalopods have been collected from the lower shale, but as yet no identifiable cephalopods have been found. The stratigraphical position of these

cephalopods, immediately above the *Meekoceras* zone and below the *Tirolites* zone, strongly suggests that these cephalopods represent the *Anasibirites* fauna. Likewise the *Tirolites* limestone, judging from similarities in sequence, correlates with the succeeding limestone and silty shale member of the Fort Douglas section. The *Columbites* fauna, characteristic of the *Columbites* shale of the Bear Lake Valley, Idaho, is also found at Fort Douglas, Utah. The upper siltstone differs slightly in lithology from its probable equivalent in the Fort Douglas area. The unit at Fort Douglas contains several beds of massive limestone and some beds of red siltstone. This thick member is the Emigration formation of Mathews (1931). The upper red shale and the upper limestone members are equivalent to the upper Thaynes red beds and the thin Portneuf limestone in the Montpelier quadrangle, described by Mansfield (1927, p. 88). On a lithologic basis these two units correlate with the lower Ankareh of the Fort Douglas area as described by Mathews. It appears to me that Mathews did not recognize the full extent of the Thaynes formation at Fort Douglas, and that the lower "Ankareh" as described by Mathews is part of the Thaynes and correlative with the upper red shale and the upper limestone member of the Bear Lake Valley, Idaho. Also, Mathews' conclusions as to a Middle Triassic age for the upper Thaynes cannot be substantiated.

Sections.

The beds are given in stratigraphic sequence, the oldest at the bottom; numbers increase in ascending order.

THAYNES FORMATION.

Hot Springs, Idaho.

Sec. 18, T. 15 S., R. 45 E., Bear Lake County, Idaho.

Bed No.		Feet
	Upper limestone member.	
116	Siltstone, olive-gray, massive, weathers greenish-buff, fossiliferous, contains chert bands	5.0
115	Limestone, dark gray, friable, crystalline, fossiliferous	6.0
114	Limestone, light gray, massive, dense	20.0
113	Limestone, light gray, cavernous, weathers dark gray, prominent ridge-maker, massive	16.0
112	Siltstone, light to dark gray, contains chert nodules, lower part is a banded siltstone, upper part is a white sandstone, partially covered	20.0
	Total for unit—67.0.	

Bed No.		Feet
	Upper red shale member.	
111	Covered, gray, silty shale	10.0
110	Shale, dark brick-red, silty, partially covered	9.0
109	Siltstone, dark gray to black, quartzitic, finely laminated, iron-stained	2.0
108	Covered, probably gray shale	6.5
107	Shale, dark brick-red, silty, partially covered	7.0
106	Siltstone, olive-gray, platy	6.0
105	Shale, dark brick-red, silty	3.5
104	Siltstone, olive-gray, platy	.5
103	Shale, dark brick-red, silty, contains a few gray shale units	2.0
102	Siltstone, dark gray, platy	1.0
101	Sandstone, dark brick-red, massive	1.0
100	Sandstone, light gray, speckled, weathers olive-green	1.0
99	Siltstone, pale green, symmetrical ripple marks	1.0
98	Siltstone, light gray, calcareous, massive, finely laminated, fossiliferous	2.5
97	Shale, greenish-gray, silty, fossiliferous, partially covered	8.0
96	Siltstone, light gray, massive	3.0
95	Covered, probably gray, silty shale	7.2
94	Siltstone, brownish-red, massive, forms prominent scarp	16.0
93	Shale, dark brick-red, and siltstone, pink, platy, contains several gray beds, mostly covered	226.0
92	Covered, probably gray-buff siltstone and shale, dip 66 degrees E.	195.0
	Total for unit—508.2.	
	Upper siltstone member.	
91	Covered, limestone and siltstone talus, dip 56 degrees W.	121.0
90	Siltstone, gray-buff, massive, contains numerous fractures, fossiliferous, weathers dark brown	5.0
89	Limestone, purplish-gray, massive, fossiliferous	.5
88	Siltstone, gray, weathers dark brown to tan	37.0
87	Limestone, gray, finely crystalline, massive, weathers gray, contains fossils	6.0
86	Siltstone, olive-gray, massive to platy, weathers gray to dark brown	21.0
85	Limestone, dark gray, fine-grained, friable, massive	1.5
84	Siltstone, dark blue-gray, calcareous, massive, some slabby layers, weathers brown	6.0
83	Siltstone, dark olive-buff, shaly, irregularly-bedded	5.0
82	Limestone, gray, fine-grained, friable, massive, fossiliferous (pectinoids)	1.0
81	Siltstone, olive-gray, shaly, irregularly-bedded, calcareous, weathers gray	6.5
80	Limestone, like bed 82	3.0
79	Siltstone, olive buff-gray, massive to platy, weathers gray to brown	22.0
78	Limestone, gray, fine-grained, and siltstone, buff, interbedded	6.0
77	Siltstone, olive-gray, platy to massive, weathers dark brown	9.0
76	Limestone, dark gray, friable, massive, fossiliferous	1.0
75	Siltstone, olive-gray, shaly, mostly covered	3.0
74	Limestone, dark gray, irregularly-bedded, contains silty layers, fossiliferous	5.0

Bed No.		Feet
73	Siltstone, gray, massive, weathers dark brown, calcareous	2.8
72	Limestone, dark gray, massive, contains several silty layers which weather brown, partially covered	16.0
71	Siltstone, gray to buff, massive, platy in part, weathers dark brown, desert varnish on surface	13.5
70	Limestone, light gray, sugary texture, fossiliferous	3.0
69	Siltstone, dark gray, massive, weathers dark brown	5.0
68	Siltstone, olive-buff, platy and shaly, weathers light buff, partially covered	11.0
67	Limestone, light to dark gray, crystalline, massive, fossiliferous	6.5
66	Siltstone, gray to buff, weathers platy and dark brown	32.0
65	Limestone and siltstone, interbedded	5.0
64	Siltstone, olive-buff, shaly, fossiliferous	5.0
63	Siltstone, gray, calcareous, fine-grained, contains numerous calcite veins, weathers dark to reddish-brown	10.0
62	Limestone, gray, friable, massive, fine-grained, fossiliferous	11.0
61	Limestone, dark gray, silty, shaly, fossiliferous	2.0
60	Siltstone, dark gray, calcareous, friable	4.0
59	Siltstone, dark buff, weathers dark brown, massive	6.0
58	Siltstone, dark gray, massive, weathers dark brown, partially covered	22.0
57	Limestone, light gray, finely crystalline, massive, contains a few fossils	5.0
56	Siltstone, dark gray, massive, weathers dark brown	20.0
55	Covered (platy siltstones?)	6.0
54	Siltstone, gray, massive, shaly, weathers dark brown	32.0
53	Limestone, gray, fine-grained, massive, weathers reddish-brown	.5
52	Siltstone, tan, shaly, weathers dark brown, lower part partially covered	32.0
51	Siltstone, gray, calcareous, massive, weathers reddish-brown	1.5
50	Siltstone, dark gray, shaly, partially covered	9.0
49	Siltstone, dark gray, massive and shaly, weathers olive-green	4.0
48	Shale, olive-green, silty	10.0
47	Siltstone, dark gray, platy, mostly covered	5.0
46	Limestone, gray, massive	2.0
45	Shale, gray, silty, mostly covered	12.0
44	Siltstone, olive-gray, massive	2.5
43	Covered, platy, buff siltstone and shale	60.0
42	Siltstone, gray, shaly, irregularly-bedded, upper part covered	30.0
41	Siltstone, gray, shaly, weathers dark brown	17.0
40	Covered (like beds 42 and 41)	45.0
39	Like bed 42	5.0
38	Covered (like beds 42 and 41)	50.0
37	Slope covered with rock glacier of gray siltstone slabs that weather a red to brown color	135.0
36	Siltstone, gray, slabby, weathers red and brown	17.0
35	Covered (like bed 36)	22.0
34	Siltstone, buff to gray, massive, weathers brown	15.0
33	Covered, rock talus or glacier of siltstone, several small outcrops in place seen	50.0
32	Siltstone, buff, platy, weathers tan and red, lower part mostly covered	145.0

Total for unit—1145.8.

Bed No.		Feet
	Columbites shale member.	
31	Shale, black, silty, contains numerous black limestone concretions, fossiliferous; this is the *Columbites* zone	18.0
30	Shale, black, silty, contains concretions as bed 31, contains *Columbites* fauna, dip 63 degrees E., strike 4 degrees E. of N.	65.0
	Total for unit—83.0.	
	Tirolites limestone member.	
29	Limestone, blue-gray, platy, thin-bedded, partially covered, contains *Pentacrinus* stem ossicles	18.0
28	Limestone, dark gray, massive, fine-grained, fossiliferous, contains *Pentacrinus* stem ossicles, forms first scarp below *Columbites* zone	12.0
27	Siltstone, steel- to dull-gray, slabby, fossiliferous, contains pectinoids, upper part covered	15.0
26	Limestone, steel-gray, more or less massive, silty, hard, fossiliferous, partially covered	4.0
25	Siltstone, buff, slabby, mostly covered	4.0
24	Limestone, gray, crystalline, massive, fossiliferous, contains pectinoids	1.5
23	Siltstone, gray-buff, calcareous, weathers olive-buff, partially covered	15.0
22	Limestone, gray, massive, crystalline, fossiliferous, contains pectinoids and brachiopods	2.0
21	Siltstone, dark gray to black, slabby, calcareous, weathers brown	3.0
20	Limestone, dark gray, hard, dense, fine-grained, contains brachiopods, massive	8.0
19	Siltstone, steel-gray, hard, massive, calcareous, weathers olive-buff and gray	5.0
18	Limestone, gray, fine-grained, hard, massive, with several 1- or 2-foot silty, shaly limestone units, contains a few fossils	15.0
17	Limestone, gray, fine-grained, hard, weathers light buff and in irregular pointed surfaces, makes prominent scarp	10.0
16	Covered (Siltstone, buff, platy)	17.0
15	Limestone, dark gray, finely crystalline, massive, makes scarp, contains brachiopods	14.0
14	Covered (Siltstone, buff, platy)	15.0
13	Limestone, gray, hard, contains some coquinoid bands of brachiopods	13.0
12	Limestone, light to dark gray, massive, forms prominent scarp, somewhat fossiliferous, lower 10 feet partially covered	40.0
11	Limestone, gray, thin-bedded, interbedded with olive-buff siltstone	17.0
10	Limestone, dark gray, finely crystalline, massive, contains brachiopods, forms first scarp above *Meekoceras* zone	7.0
9	Siltstone, olive-gray, calcareous, hard, massive, weathers brown	20.0
	Total for unit—228.5	
	Lower shale member.	
8	Shale, buff to gray, mostly covered	145.0

Bed No.		Feet
7	Shale and platy siltstone, mostly covered, lower 20 feet is a black bituminous shale and siltstone, one black limestone concretion found	80.0
6	Siltstone, gray, calcareous, slabby, weathers brown	4.0
	Total for unit—229.0	
	Meekoceras limestone member.	
5	Limestone, light gray, massive, contains pure calcite bands along bedding plane, weathers dark gray	11.0
4	Limestone, gray, thin-bedded, fossiliferous, contains pelecypods, weathers gray	3.2
3	Limestone, gray, rather thin-bedded, contains cephalopods (*Meekoceras* fauna)	9.5
2	Limestone, gray, thin-bedded	21.5
1	Limestone, gray, thin-bedded	7.0
	Total for unit—52.2	
	Total Thaynes	2313.7

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