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THE LIZARDS OF THE MIDDLE PAHVANT VALLEY, UTAH; MATERIALS FOR A STUDY IN SAURIAN DISTRIBUTION

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INTRODUCTION

IN the light of the excellent studies of Ruthven and the recent, brilliant work of Klauber in the field of reptilian distribution, it is with some hesitancy that the following paper is presented; but studies in this particular phase of herpetological investigation are so few that I feel that any work, however meager, must prove of some value in furthering our knowledge of reptilian ecology. The material embodied in this paper is, moreover, of a slightly different nature than that presented by Ruthven in his several papers or by Klauber, in that the area treated is much smaller and the fauna vastly more limited as compared with the material discussed by these investigators.

It has been my purpose to study intensively the distribution of forms in an exceedingly small area in an effort to discover some order in what superficially appears to be a chaotic hodgepodge. As a result of this intensive study with limited materials, it has been possible to establish certain principles which seem to offer the key to the saurian distribution of the region examined, and it is probable that these conclusions may be applied to other areas. I am firmly convinced that our knowledge of reptilian distribution must be based on studies of very minute units if the presence or absence of a form in larger areas is to be explained. I have found that as small a factor as a few square yards of lava projecting above a sandy plain may explain the distribution of a form in increasingly larger areas. It will be my purpose in this paper to point out how certain principles may be applied and to explain exceptions to these principles on the basis of the animals' life history.

The conclusions here presented are the results of field data collected during a six-weeks' stay at Fillmore, Utah, in July and August, 1931, during which time a collection of over 450 lizards was secured. For the opportunity of carrying on the investigations and for financial support I am indebted to the University of Michigan. To Dr. Alexander G. Ruthven in particular, I wish to express my thanks for data placed at my disposal and for the numerous suggestions made during the course of the work. I am further indebted to Mrs. H. T. Gaige, Dr. L. R. Dice, Dr. J. Van Tyne, and Mr. J. B. McFarlin, all of the University of Michigan Museums, for aid in plant and animal identifications and for other services rendered me, and to my friends in Fillmore, Utah, for their assistance during my stay there.

GENERAL DISCUSSION OF THE REGION

Location.—Fillmore is located in the eastern part of Millard County, Utah; it is at an elevation of 5100 feet. The town lies on the eastern edge of the Pahvant[1] Valley and at the western base of the Pahvant Mountains. At this point the mountains mark the western edge of the Colorado Plateau Province;[2] the valley lies on the eastern border of the Basin and Range Province.[2] The Pahvant Valley is bordered on the east by the Pahvant Mountains, on the west by the Cricket Range, on the south probably by the Mineral Range, and on

[1] Also spelled *Pavant.*

[2] Fenneman, W. M.: *Physiography of Western United States,* New York, 1931, map.

the north by the Oak Creek Range. It is about 55 miles long and about 40 miles wide. The area which was studied is shown in Map 1.

Geology.—The Pahvant Valley is situated in part of the area covered by the Sevier Body of Lake Bonneville.[3] As a result the valley floor is very flat; the mountains rise abruptly from the desert on all sides. Although the floor contains much alluvial matter from the mountains in addition to local deposits of sand, gypsum, and alkali, the igneous intrusions constitute the main feature of the region. Gilbert summarizes the area as follows:

> Of the various volcanic districts of Utah, that which is most interesting in this connection occupies the eastern portion of the Sevier Desert in the vicinity of the towns of Holden, Fillmore, Corn Creek, Kenosh, and Deseret. The Pavant Range there forms the eastern limit of the desert plains, and is itself composed of uplifted strata ranging in age from Carboniferous to Tertiary. The volcanic buttes and tables, all very small as compared with the mountain range, rest upon the open plain, at distances varying from 10 to 30 miles. Nearest to Fillmore is the Ice Spring lava field with its cluster of craters. Just south of it are the Tabernacle field and crater. . . . North of the Ice Spring field there is a continuous volcanic tract, some 10 miles in extent, for the most part coincident with the plain, but including also a large mesa opposite Holden, and a large tuff cone, Pavant Butte.[4]

Climate.—The climate in the region of Fillmore may be defined as semi-arid. This condition exists throughout the desert, but in the mountains to the east a humid area is immediately evident. Table I shows the mensual climatic data at Fillmore over a period of 26 years, dating from 1889 to 1915.[5]

TABLE I

	J	F	M	A	M	J	J	A	S	O	N	D
R.F.″	1.15	1.54	1.81	1.78	1.48	0.56	0.78	0.83	1.20	1.12	1.01	1.11
F.°	30.5	34.1	41.7	50.0	57.8	67.6	75.2	74.4	64.8	52.6	41.8	29.2

Average annual R.F.″ 14.37 Average annual Temp. F.° 51.7

[3] Gilbert, G. K.: "Lake Bonneville," *U. S. G. S., Mon.* I, 1890, pl. III.

[4] Gilbert, G. K.: *op. cit.*, p. 319.

[5] West, W. F., and Edlefsen, N. E.: "The Climate of Utah," *Utah Agr. Coll. Exp. Sta., Bull.* 166, 1919, p. 58, 62.

It is to be noted that there is a deficiency of rainfall throughout the year with a winter maximum. By the Köppen classification[6] it would be classified as *BSks* or desert margin. The average growing season, about 120 days, extends from May 23 to September 20.[7]

The summer of 1931 was unusual climatically, the diurnal maximum was generally over 100° F. and the minimum above 70° F. The drought was severe; there was less than one inch of rainfall from early spring to late August.

Biology.—The vegetation of the desert flats is largely made up of the sagebrush association. The more common plants are sagebrush (*Artemisia tridentata*), rabbit brush (*Chrysothamnus* sp.), thistle (*Salsola* sp.), and greasewood (*Sarcobatus* sp.). The juniper (*Juniperus* sp.) also occurs in local patches, but trees on the flats are rare. Very little cultivation has succeeded in the region, and alfalfa alone is grown to any extent.

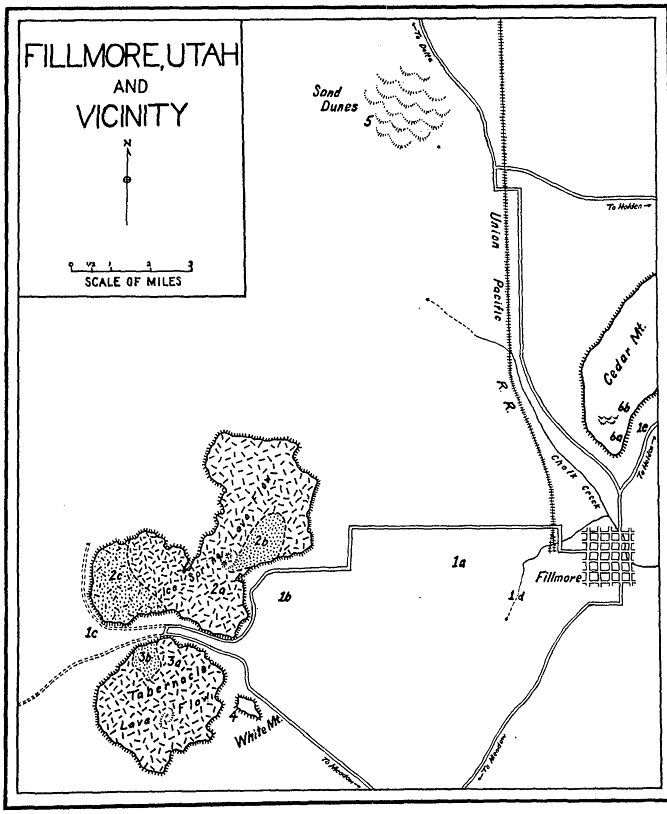
Among the animals of the region the jack rabbit (*Lepus c. erimicus* ?), the cottontail (*Silvilagus n. grangeri* ?), and the ground squirrel (*Citellus* sp.) are abundant. The commoner birds are sparrows, shrikes, the red-tailed hawk, sharp-tailed grouse, and, along irrigation ditches, killdeer. Ants, leaf bugs, grasshoppers, dragonflies, robber-flies, and wasps are the most conspicuous insects. Cattle are pastured only to a very small extent on the desert.

HABITAT STUDIES

Inasmuch as the region dealt with is made up of igneous intrusions, gypsum deposits, sand areas, etc., resting upon the desert flats, a number of saurian habitats are to be expected. In the area studied, six major and twenty-one minor habitats exist. It is to be understood that several of the twenty-one separate geographic areas examined are similar and occur in various parts of the valley. The following is an outline list of the habitats to be discussed.

[6] Köppen, W.: *Die Klimate der Erde,* Berlin, 1923, map.

[7] West and Edlefsen: *op. cit.,* p. 64.



MAP 1.—A map of the Fillmore area constructed from field sketches, U. S. Forest Service maps, and Plate XXXV of Gilbert's *Lake Bonneville.* The major habitats are numbered as follows: 1.—Desert Flats; 1a.—Gravel *Artemisia* Association; 1b.—Transition *Artemesia* Association; 1c.—Sand *Artemesia* Association; 1d.—*Verbascum* Association; 1e.—*Juniperus* Association; 2.—Ice Spring Lava Field; 2a.—Lava; 2b.—Ash Beds; 2c.—Sand-covered Lava; 3.—Tabernacle Lava Field; 3a.—Lava; 3b.—Ash Beds; 4.—White Mountain; 5.—Sand Dunes; 6.—Cedar Mountain; 6a.—Slopes and Benches; 6b.—Summit. The numbers are placed at approximately the exact regions worked.

- I. Desert Flats
  - A. *Artemisia* Association
    - 1. Gravel flats
    - 2. Sand flats
    - 3. Transition flats
  - B. *Verbascum* Association
  - C. *Juniperus* Association
    - 1. Gravel area
    - 2. Sand area
- II. Sand Dunes
  - A. Dunes Proper
  - B. Interdunal Areas
- III. White Mountain
  - A. Summit
    - 1. Rock outcrop
    - 2. Sand area
    - 3. Transition area
  - B. Slopes and Benches
    - 1. Sand area
    - 2. Gravel area
- IV. Cedar Mountain
  - A. Summit (sand)
  - B. Slopes and Benches (gravel)
- V. Lava Flows
  - A. Ice Spring Field
    - 1. Ash beds
    - 2. Lava beds
    - 3. Sand covered lava
      - a. Sand
      - b. Lava
  - B. Tabernacle Field
    - 1. Ash beds
    - 2. Lava beds
- VI. Foothills

I shall treat each of the above separately in the order mentioned and show how the saurian fauna of each habitat is distributed over it. Map 1 shows the location of the major regions and some of the minor areas.

The following is a list of the lizards of the region:

1. *Crotaphytus collaris baileyi* (Stejneger)
2. *Crotaphytus wislizenii* Baird and Girard
3. *Uta stansburiana stansburiana* (Baird and Girard)
4. *Sceloporus elongatus* Stejneger
5. *Sceloporus graciosus graciosus* (Baird and Girard)
6. *Phrynosoma douglassii ornatissimum* (Girard)
7. *Phrynosoma platyrhinos* Girard
8. *Cnemidophorus tessellatus tessellatus* (Say)
9. *Eumeces skiltonianus* (Baird and Girard)

Desert Flats

The desert flats comprise the most widely distributed habitat in the area. Despite their presence throughout the region three general types can be recognized on the basis of vegetation.

Artemisia Association.—This habitat is wide-spread throughout the valley, and the vegetation type is the most common in the region. Owing to the physiographic history of the area, three subtypes can be placed in this group on the basis of soil. Near the mountains to the east lies the Bonneville shore line. As would be expected, here lie gravel flats made up of lake shore deposits and coarser alluvial material washed from the mountains. The gravel area grades into sandy gravel farther away from the shore lines, and with it a finer alluvial material has also been deposited. Finally, well out on the desert lie the sand flats, which are well offshore in the glacial lake and in a position to receive only the finest alluvial material from the mountains. From this the formation of the three subtypes can be readily understood.

Gravel flats.—These flats cover the entire area from the mountain bases to a distance of about 10 miles out on the desert. The dominant vegetation type is sagebrush (*Artemisia*) interspersed with some rabbit brush (*Chrysothamnus*). The bushes are small, rarely over two feet in height, and vary in density from only one or two every 50 feet to masses so dense as to be almost impenetrable. Little or no grass grows on the flats. The ground is perforated with the burrows of small mammals; sparrows, shrikes, and other small birds are common. Insect life consists largely of grasshoppers and leaf bugs.

The saurian fauna here is limited to two species, *Uta s. stansburiana* and *Sceloporus g. graciosus.* Both are common. They are found sunning themselves near sagebrush under which they seek refuge when disturbed. The former generally scurry down the nearest hole when chased, while the latter usually climb up the branches of an adjacent sagebush and do not seek shelter in holes until repeatedly disturbed.

Plate I, Figure 1 shows the typical gravel flat type of soil and vegetation covering.

Sand flats.—The sand area proper occupies most of the valley, beginning about 15 miles from the base of the mountains. For the most part it is made up of rather hard-packed sand, locally incrusted with alkali in depressions; occasionally it shows a tendency towards dune formation. The vegetation is sagebrush and rabbit brush throughout, with some greasewood (*Sarcobatus*) in the alkaline areas. Plate I, Figure 2 shows the type of country, although it is misleading in that it shows rabbit brush to be the dominant plant form which is the situation in only a very few areas. Rabbits and other small mammals are present, but very few birds were noted. Grasshoppers and flies are the dominant insects.

On the sand flats are *Crotaphytus wislizenii* and *Cnemidophorus t. tessellatus,* the latter predominating. Both the lizards are commonly found quietly sunning themselves in the open, and when disturbed they run long distances with great rapidity into the dense shelter of some large bush or seek refuge down a hole. A single specimen of *Phrynosoma platyrhinos* was found on an alkaline area near the Ice Spring lava field, and an occasional *Uta s. stansburiana* was noted in the same area, which has led me to believe that these two forms are not indigenous to the sand flats. *Sceloporus g. graciosus* is not present.

Transition flats.—The transition flats occupy the area between the gravel flats and the sand flats. They are poorly defined throughout the region, but the transitional saurian fauna makes the habitat clearly evident when closely studied. The soil type is a hard sandy-gravel. Vegetation is largely sagebrush, similar to the gravel flats. Plate I, Figure 1 might apply to this area as well as to the gravel habitat. Here again small burrowing animals, especially rabbits, are abundant. Insects present are predominantly ants, grasshoppers, and leaf bugs.

As would be expected, the saurian fauna is found to be transitional. *Cnemidophorus t. tessellatus, Crotaphytus wislizenii,* and *Uta s. stansburiana* are common, but *Sceloporus g. graciosus,* whose distribution is a most perplexing problem as will be noted later, is abundant.

Verbascum Association.—This habitat might well be considered a subtype of the *Artemisia* association, but since it occupies the narrow moist area along a branch of Chalk Creek and runs directly through the center of the gravel flats, it has been considered as a separate type. The habitat is very restricted, occupying only a few feet on both sides of the stream, which has been widened and deepened for irrigation purposes. Along both sides boulders taken from the stream bed have been piled up. In this area in addition to mullein (*Verbascum thapsus*), are found small shrubs, grass, and great heaps of tumbleweed (*Salsola*) which has been deposited by the wind.

Rabbits and other small rodents are abundant, and sheep graze in the area. Although early in the season few insects were noted, there was a great emergence of grasshoppers over the habitat early in August.

The saurian fauna is derived, for the most part, from the adjacent gravel flats. Although early in July few lizards were found climbing over the rocks beside the stream, hundreds of *Sceloporus g. graciosus* were present in August.

Uta s. stansburiana was almost lacking, a peculiar circumstance to be explained later. A single *Cnemidophorus t. tessellatus* was found, but since it did not occur on the adjacent flats, I believe it was a wanderer from some other area. Two specimens, one of which was secured, of *Eumeces skiltonianus* were seen along the banks hiding under the rocks and tumbleweed. The presence of *Eumeces* here, and here alone, will be discussed later.

Plate II, Figure 1 shows the *Verbascum* association along this small stream and gives a clear idea of its limited extent.

Juniperus Association.—The *Juniperus* association is distributed in small patches over the desert flats but is normally limited to the higher elevations. Where studied, almost in the foothills of the mountains, it covers several square miles in area. It lies at the base of a long offshore bar stretching from the Pahvant Mountains to Cedar Mountain (see Map 1). At the base of this gravel bar there is a local sandy area upon which, in patches, occurs coarser soil. The area is completely surrounded by the gravel *Artemisia* association.

The vegetation of the habitat is sparse, predominantly *Juniperus,* with scattered sagebrush, rabbit brush, and an occasional patch of squaw bush (*Rhus trilobata*). Rabbits and ground squirrels are common, and sparrows, shrikes, and hawks are generally distributed over the area. Grasshoppers, leaf bugs, ants, and beetles make up the bulk of the insect life. Considering the region as a whole the saurian fauna is quite varied. Along the gravel bar and occasionally on the finer soil at its base *Uta s. stansburiana* is present. On the sandy areas *Cnemidophorus t. tessellatus, Crotaphytus wislizenii,* and *Sceloporus g. graciosus* are exceedingly common, particularly the young of *Crotaphytus* which are hatched early in August. *Sceloporus g. graciosus* is present on and about the sagebrush, while *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii* are always found in the open areas. A single specimen of *Phrynosoma platyrhinos* was seen at the base of the gravel ridge.

Plate II, Figure 2, although not a picture of the particular area studied, shows the conditions of vegetation existing on the habitat.

Sand Dunes

The sand dunes, formed by the deposition of sand brought in by the southwest wind, cover an extensive area in the northern part of the valley. They are moving in a northeasterly direction, and are irregular in position, with no festooning. They are rarely over 15 feet high; the gradual slope faces to the windward. Between the separate dunes are harder-packed sand areas, which in contrast to the barren dunes, support a heavy growth of tumbleweed (*Salsola*) and rabbit brush. Sagebrush is almost entirely absent except where it has taken possession of and fixed some of the peripheral dunes. Sage flats completely surround the dune area. The contrast between the moving dunes of soft sand, almost barren of vegetation, and the hard, vegetated interdunal areas is great enough to warrant two subtypes of this habitat. A view across the dunes is shown in Plate III, Figure 1.

Dunes Proper.—For the most part the dunes themselves are made up of soft shifting sands almost devoid of life. Occasionally a local growth of squaw bush (*Rhus trilobata*), rabbit brush, or thistle can be found, but plant life is, in general, lacking. Except for a few colonies of burrowing wasps, animal life, likewise, avoids the unvegetated areas. The saurian fauna here is abundant wherever a little vegetation presents itself, although it is limited to a single species, *Sceloporus g. graciosus*. Under one squaw bush this species fairly swarmed; nineteen were collected in about ten minutes. A single dead specimen half-buried in the sand was found on an open dune. Apparently lizards do not find the soft sand a favorable habitat except where vegetation provides cover for food.

Interdunal Areas.—The interdunal areas form a striking contrast with the dunes proper in that they are made up of heavily vegetated, packed sand. Plate III, Figure 1 shows this contrast if the dunes in the left background are compared with the interdunal area in the right background. Here the vegetation is largely tumbleweed with some rabbit brush and greasewood in local patches. The tumbleweed dries and is heaped up into wide-spread low masses which are almost impenetrable. Rabbits are fairly numerous and insect life quite abundant.

The saurian fauna is also richer. *Sceloporus g. graciosus,* commonly found along the edges of the tumbleweed masses, is practically impossible to secure, since it immediately takes refuge in the brush when disturbed. *Crotaphytus wislizenii* is abundant and can always be found basking in the sun on the open sand areas between the vegetation masses. It seems to prefer the open, in contrast to *Sceloporus,* and will not seek protection of the brush unless repeatedly disturbed. In much smaller numbers *Cnemidophorus t. tessellatus* also occurs, but it does not seem to have been very successful in this rather densely thicketed habitat.

White Mountain

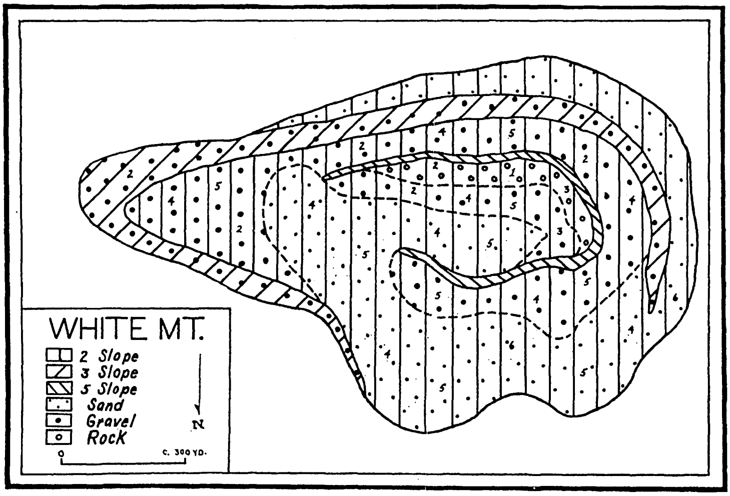
Gilbert[8] offers but a short paragraph with reference to White Mountain which sums up its formation:

> Just east of the Tabernacle lava field is a hill of grey rhyolite one or two hundred feet high. It is a worn remnant, with nothing in its aspect to aid conjecture as to its original extent. Its base is concealed by the lake beds, and its sides show terracing by the waves of Provo and Intermediate times. Lying to the leeward of a gypsum playa, it has acquired a white mantle of gypseous sand dunes, whence it is called White Mountain. . . .

Map 2 is a rough map of the mountain constructed from a field sketch in which slope and soil types are simultaneously plotted. Surrounding the base on all but the east side are gypsum dunes which are piled up irregularly. Lying above these are gravel benches which on the east side slope gradually up to the summit. On all the other sides the summit is bordered by steep rocky cliffs which give it the appearance of a

[8] Gilbert, G. K., *op. cit.*, p. 338.

crown resting on a lower hill. The cliffs are about 50 feet in height.



MAP 2.—A map of White Mountain constructed from a field sketch and showing slope, soil types, and saurian distribution. The figures indicate the following species: 1.—*Sceloporus elongatus;* 2.—*Uta s. stansburiana;* 3.—*Phrynosoma platyrhinos;* 4.—*Cnemidophorus t. tessellatus;* 5.—*Crotaphytus wislizenii;* 6.—*Sceloporus g. graciosus.* The slopes are numbered according to the classification of the Michigan Land Economic Survey, not accepted as standard in many states.

Summit.—The summit of White Mountain, although small in area, offers an excellent series of habitats for studies in saurian distribution. The rhyolite cliffs continue as an outcrop on the southern and western edges, between them a zone of gravel grades into the gypsum bordering the eastern and northern sides. The surface is almost level except on the east where it slopes gradually down to the bench. Rabbits and burrowing rodents are abundant here, and hawks and small birds are common. Grasshoppers, leaf bugs, beetles, and similar insects offer an excellent food supply to the lizards.

The rocky and gravel areas support a sparse growth of sage, rabbit brush, and thistle, while the sandy area is largely rabbit brush interspersed with sage, thistle, and *Croton longipes.*

Five species of lizards are present on the summit. On the rhyolite outcrop *Uta s. stansburiana* is abundant, and *Sceloporus elongatus* occurs in small numbers. These two forms, found basking on the broken boulders and overhanging shelves of rock, scurry into crevices when disturbed. *Phrynosoma platyrhinos* is also present but not common. On the sandy area *Crotaphytus wislizenii* and *Cnemidophorus t. tessellatus* are the only forms found. Both are common, although the latter occurs in greater numbers. On the gravel area, intermediate between the rocks and sands, the two faunas overlap. *Uta s. stansburiana* and *Phrynosoma platyrhinos* are present in small numbers, and *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii* also occur. *Sceloporus elongatus* appears to be limited to the rock outcrop. It is rather amazing that in so small an area the various species indicate very marked preference for the several habitats. Map 2 shows the distribution of the saurian fauna on the mountain.

Slopes and Benches.—For the most part the base of White Mountain is surrounded by the gypsum dunes. Above this area on the south, west, and north sides lies a rather narrow gravel bench which flares out broadly on the east. The sandy areas support a sparse growth of rabbit brush and *Croton longipes;* the gravel soils are largely covered with sagebrush. As on the summit, rodents are abundant, and insect life is plentiful.

Here again the distribution of the saurian fauna is striking. The lower levels of the sand areas support *Sceloporus g. graciosus, Cnemidophorus t. tessellatus,* and *Crotaphytus wislizenii.* On the gravel *Uta s. stansburiana* replaces *Sceloporus g. graciosus; Crotaphytus wislizenii* and *Cnemidophorus t. tessellatus* are not so common as on the sandy areas.

Cedar Mountain

Cedar Mountain is a long, low hill lying to the north of Fillmore. It is probably 300 feet high, 4 miles long, and about

1 mile wide. Its origin is unknown, but it existed in pre-Bonneville times, as its sides show poorly-defined terracing resulting from wave action. For the most part it is made up of gravel and boulders, but on the summit at the south end is a local deposit of sand. It is covered with a sparse growth of juniper, as its name implies, and might well be considered an extension of the *Juniperus* association of the Desert Flats, since the two areas lie in close proximity to each other. Sage and rabbit brush grow in small numbers between the junipers. Plate II, Figure 2 gives a clear idea of the vegetation covering.

Animal life includes numerous rabbits, porcupines, and other rodents. Hawks, sparrows, and shrikes are common. Insect life is largely made up of grasshoppers, beetles, leaf bugs, and ants.

Summit.—The summit of Cedar Mountain where studied is, as has been noted, a small sandy area on the south end of the mountain. The vegetation and animal life is similar to that of the gravel slopes; the soil alone differs. Neither of the two species of lizards present, *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii,* is common. When observed, they are usually found resting or crawling over the sand in the more open areas.

Slopes and Benches.—The saurian fauna of the slopes and benches of Cedar Mountain differs markedly from that of the sandy summit, despite the similarity of other animal life and of vegetation. Here *Uta s. stansburiana* swarms over the rocks; *Phrynosoma platyrhinos* occurs in smaller numbers. *Cnemidophorus* and *Crotaphytus* are absent.

It is to be noted that the distribution of lizards on the mountain coincides with that of the *Juniperus* association which adjoins, with the exception that *Sceloporus g. graciosus* is absent from the area.

Lava Flows

As has already been stated, the igneous intrusions of this region are characteristic. Two lava fields of little similarity were examined. The location of these fields, the Ice Spring and Tabernacle, is shown in Map 1.

Ice Spring Field.—The Ice Spring field covers an area of about 12 square miles. For a description of the field and craters I can do no better than to refer to Gilbert:

> The lavas of this region are the most recent within the Bonneville area, and their phenomenon are typical of subaerial eruption.
>
> The craters are grouped closely together, and the manner in which they overlap each other, as well as their relation to the various lava flows, demonstrate that they were formed successively rather than synchronously. Three only are preserved entire, but fragments of nine more were discovered. . . . Of the discovered crater rings no two are concentric. There have been at least twelve successive eruptions, through as many independent vents, within a radius of 1500 feet, and none of the eruptions appear to have been large.[9]
>
> About these cones are at least two distinct lava floods. The older may have the same date as the fragmental cone; the newer must pertain to the same eruption as the perfect craters. In the immediate vicinity of the cones, the older flood shows only a few islands, and is conspicuous in the possession of a soil on which the sage has taken root. The newer is soilless and plantless—not even a lichen clinging to its surface—for all that can be seen, just as the cooling left it. Its surface is a chaos of black ragged slabs of lava crust, piled as are the ice cakes that, in spring freshets, dam our northern rivers.[10]

In the vicinity of the cones are two habitats, the open, barren lava, and the vegetated soil or ash beds. On the southwestern side of the field is yet another habitat, the sand-covered lava. Plate I, Figure 1 is a picture of the craters; Plate III, Figure 2 shows the lava surface.

Ash beds.—The ash beds are made up of rather coarse, very loose grains and lie, for the most part, to the northeast of the craters (probably due to the fact that during eruption the common southwestern wind was blowing). Vegetation is scarce, being limited to sagebrush and rabbit brush. Animal life is also scarce probably because of the extreme dryness of the porous soil. Rabbits appear to be the only mammals on the area, and insect life is limited to grasshoppers, beetles, and robber-flies.

[9] Gilbert, G. K.: *op. cit.*, p. 320.

[10] Gilbert, G. K.: ''Report on the Geology of Portions of Nevada, Utah, California, and Arizona.'' *Rept., Explorations and Surveys west of the one hundredth meridian* (Wheeler). Vol. III (pt. 1), 1875, p. 140.

The saurian fauna is confined to *Cnemidophorus t. tessellatus* and *Uta s. stansburiana.* It is interesting to note that the utas were all young specimens and were taken in the immediate vicinity of the barren lava, a fact to be commented upon later.

Lava beds.—Rough, jagged blocks of lava scattered in a great mass, often 30 feet in height, make up most of the area. Vegetation is almost nil; some sagebrush has taken root where a little soil has been deposited. Animal life, likewise, is almost entirely lacking. Within the craters there are no lizards, probably because of the extremes in temperature; on the lava a few specimens of *Crotaphytus c. baileyi* and *Uta s. stansburiana* are found. A single specimen of *Cnemidophorus t. tessellatus* was captured on the lava just off the ash beds. This latter form is also present on small ash islands surrounded by lava, but *Crotaphytus c. baileyi* seems to be restricted to the lava itself.

Sand covered lava.—This limited area, already located, of small islands of lava, generally covering about 100 square feet, rises above the sand which is being deposited by the southwest wind. Vegetation is limited to sagebrush and rabbit brush, and the other conditions resemble those of the sand flats near which the area is situated.

Three species of lizards are found here, *Crotaphytus wislizenii, Cnemidophorus t. tessellatus,* and *Uta. s. stansburiana.* It is important to note that the former two are always found on the sand, while the last named, with the exception of juvenile specimens, is restricted to the lava projecting above the sand. Thus two habitats might be said to be present here rather than one.

Tabernacle Field.—The Tabernacle field lies directly south of the Ice Spring field. It is roughly circular in outline and covers an area of about 7 square miles. A comparison of the surface of the lava of the two fields shows a great contrast. Gilbert sums up the general appearance of the field as follows:

> The Tabernacle field, though by no means smooth, is far less rugged than the Ice Spring. Some of the surface is broken into blocks, which

are so far displaced that they are not easily traversed on horseback; but the greater part is comparatively even. . . .

At its outer margin the lava field terminates in most directions in a cliff. . . . At a point on its eastern side it was measured and found to have a height of 65 feet.[11]

Even the vegetation of this field differs greatly from that of the Ice Spring field. On the ash beds, similar to those of the Ice Spring field, sagebrush and rabbit brush are well established; the lava is covered with lichens, and sage is by no means uncommon, growing from the numerous crevices in the great, broad igneous blocks. Animal life consists of rodents, bats, which inhabit the numerous caves perforating the flow, and grasshoppers, leaf bugs, beetles, ants, and other insects. Two habitats are present here, the flat sheets of lava, and the ash beds.

Ash beds.—On the fine, porous ash beds, the vegetation is similar to that of the gravel flats, as, indeed, is the whole character of the habitat. Here are found *Cnemidophorus t. tessellatus* in some abundance, *Crotaphytus wislizenii* in smaller numbers, a few specimens of *Phrynosoma platyrhinos,* and, near the lava, occasional specimens of *Uta s. stansburiana,* especially juveniles.

Lava beds.—On the lava, despite its similar vegetation, a different saurian fauna is present. *Sceloporus elongatus,* which is very common, lies on the black lava and when disturbed streaks rapidly over the surface to a projecting crevice. *Uta s. stansburiana* is equally abundant, and *Phrynosoma platyrhinos* is much more abundant here than it is on the ash beds.

Foothills

Although not properly a part of the valley, it is necessary to glance briefly at the fauna of the foothills in order to account for the presence of *Phrynosoma d. ornatissimum.* In this region the soil is rocky and is covered with boulders. Ravines have cut the surface and have broken it into a series of hills. The vegetation is largely sage, juniper, scrub oak,

[11] Gilbert, G. K.: *op. cit.,* 1890, p. 330.

and other small shrubs. The altitude of the region studied, about 6500 feet, may account for the apparent scarcity of animal life. The saurian fauna here is extremely scarce. A few specimens of *Sceloporus g. graciosus* and *Uta s. stansburiana* were found. *Phrynosoma d. ornatissimum* is quite common. This form was also taken at altitudes up to 9000 feet.

A chart, perhaps, offers the best means of summing up the distribution of the saurian fauna of the region. The contents of Table II, therefore, have been arranged in the order in which the habitats have been discussed. The purely comparative abundance noted for each species is in accordance with the following sequence: absent (denoted by dash), present, common, and abundant. An interrogation mark (?) indicates doubt as to whether or not the form is indigenous to the habitat.

DISTRIBUTIONAL FACTORS

From the data on hand, presented in the foregoing habitat descriptions, it is now necessary to examine the various factors involved in determining the distribution of the saurian fauna of the region. In as much as the numerous factors are all interwoven with each other, difficulty must necessarily arise when an attempt is made to isolate and discuss each separately. Nevertheless a short discussion of some of the more important factors may be attempted, so that they may be weighed individually before a summation is presented. Physical and biotic groups may be recognized.

Physical Factors

Into this group fall the climatic and geologic elements. Since they primarily determine the general aspect of the region and make up the basic conditions under which life exists, they may be considered first.

Climate.—The general recognizable conditions of precipitation, evaporation, heat, winds, etc., are probably the same throughout the small area under discussion, consequently

TABLE II

Habitats			CROTAPHYTUS C. BAILEYI	CROTAPHYTUS WISLIZENII	UTA. S. STANSBURIANA	SCELOPORUS ELONGATUS	SCELOPORUS G. GRACIOSUS	PHRYNOSOMA D. ORNATISSIMUM	PHRYNOSOMA PLATYRHINOS	CNEMIDOPHORUS T. TESSELLATUS	EUMECES SKILTONIANUS
Desert Flats	Artemesia Association	Gravel Flats	—	—	Abundant	—	Abundant	—	—	—	—
		Sand Flats	—	Common	Present?	—	—	—	Present	Abundant	—
		Transition Flats	—	Common	Present	—	—	—	—	Abundant	—
	Verbascum Association		—	—	Present	—	Abundant	—	—	Present?	Present
	Juniperus Association	Gravel	—	—	Common	—	—	—	Present	—	—
		Sand	—	Abundant	Present?	—	Abundant	—	—	Abundant	—
Sand Dunes	Dunes Proper		—	—	—	—	Abundant	—	—	—	—
	Interdunal Areas		—	Common	—	—	Common	—	—	Present	—
White Mountain	Summit	Rock Outcrop	—	—	Abundant	Present	—	—	Present	—	—
		Sand Area	—	Common	—	—	—	—	—	Common	—
		Transition Area	—	Present	Present	—	—	—	Present	Present	—
	Slopes and Benches	Sand	—	Common	—	—	Common	—	—	Common	—
		Gravel	—	Common	Present	—	—	—	—	Present	—
Cedar Mountain	Summit		—	Present	—	—	—	—	—	Present	—
	Slopes and Benches		—	—	Abundant	—	—	—	Common	—	—
Lava Flows	Ice Spring Field	Ash Beds	—	—	Present?	—	—	—	—	Common	—
		Lava	Common	—	Common	—	—	—	—	Present?	—
		Sand-covered Lava: Sand	—	Common	—	—	—	—	—	Common	—
		Sand-covered Lava: Lava	—	—	Abundant	—	—	—	—	—	—
	Tabernacle Field	Ash Beds	—	Present	Present	—	—	—	Present	Common	—
		Lava	—	—	Abundant	Abundant	—	—	Abundant	—	—
Mountain Foothills			—	—	Present	—	Present	Abundant	—	—	—

climate as a whole may be neglected and broken down into its component parts.

Heat.—Insulation is probably constant, since the altitude of the region is almost the same throughout. The important factor to be noted is the absorption and retention of the heat received. I believe that this factor controls the time of activity of the forms but has no relation to the actual presence or absence of any particular species on a habitat. Throughout the area it was noted that all the species were generally active from about 8:00 A.M. until 11:30 A.M. Inactivity, during which time the lizards probably seek shelter beneath the ground, follows until about 4:00 P.M. Although less pronounced in the afternoon, a period of activity extends from 4:00 P.M. until sunset.

With reference to the absorption and retention of heat, it is interesting to note briefly the conditions existing on the craters. The black surface of the lava reflects very little heat as compared with sandy and lighter colored areas. As a result by noon the lava becomes so hot as to burn the hand. Within the craters the heat is terrific. During the night, however, nocturnal air drainage causes these depressions to become very cold. A daily range of perhaps 70° F. exists. Since no saurian life is found within the craters, other conditions of which are similar to those on the lava, it is not illogical to presume that this diurnal range of temperature prohibits life. Heat in this instance may be a distributional factor.

I believe that heat is not a determining factor in the distribution of different forms on other habitats. The presence of *Sceloporus elongatus* on the Tabernacle field and its absence on the Ice Spring field seems to bear out this conclusion, as does the reverse condition in the instance of *Crotaphytus c. baileyi*. Again, the presence of *Cnemidophorus t. tessellatus* on both the bright sand and reddish-black ash makes this conclusion obligatory. The same arguments may be applied to light as a distributional factor.

Moisture.—Like heat, moisture may at times constitute an active factor, but for the most part I give little weight to its importance here. The extremely dry conditions on the porous lava may possibly be responsible for the relative sparseness of life. Moisture may, however, be looked upon as a determining factor in the distribution of *Eumeces skiltonianus* and *Uta s. stansburiana.* The former is generally considered an inhabitant of the moister forest areas of the mountains, and I have no doubt that its presence in the *Verbascum* association is owing to its having followed Chalk Creek down from the mountains and out on the desert. As to the latter, I shall show later that whereas soil, food, vegetation, and other characters are suitable for the maintenance of a large colony on the *Verbascum* association, it was almost completely absent. The same condition exists in Fillmore Canyon, a habitat not included in this study. It is not too illogical to suggest that *Uta s. stansburiana* does not thrive under moist conditions. Moisture conditions throughout the other areas studied are probably very much the same though differing greatly from the *Verbascum* association.

Soil.—There is little doubt in my mind that the morphology of the soil, *i.e.,* sand, boulders, gravel, etc., constitutes one of the most important factors in the distribution of lizards in the area. That some prefer fine soils while others show an affinity to coarser soils can not be contradicted on the basis of the data at hand. As has already been stated, I shall show later that food, vegetation, and other factors are of little importance. With this in mind the distribution of the forms with reference to soil is to be noted: *i.e., Uta s. stansburiana* on the gravel flats, on the boulders of Cedar Mountain, on the lava fields, particularly on the Ice Spring field where it chooses the lava in preference to the sand, and on the rock outcrops and gravels of White Mountain. The presence of *Sceloporus elongatus* and *Crotaphytus c. baileyi* on very rocky habitats, and the occurrence of *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii* on the sand and finer soils throughout the area also confirms this point of view. A careful study of the distributional chart shows clearly that certain forms are related primarily to certain soils.

Biotic Factors

Even more complex in their interrelations than the physical factors are the biotic factors, in that some of the agents under consideration move, prey upon each other, and are often complexly dependent upon each other. Although admitting that these various factors are inseparable, I shall attempt to discuss each separately.

Vegetation.—As the vegetation is more or less fixed and furnishes the basic food, indirectly for lizards, it is logical that it should be noted first. I believe that vegetation has no direct effect upon the distribution of the saurian fauna of the region. During the past several years I have examined the stomach contents of about 800 Utah lizards, and have never found any evidence of a vegetable diet. Indirectly, moreover, I can see no reason why vegetation should play any important rôle in distribution. It is true that most of the insect life is dependent in one way or another upon vegetation and that lizards are largely insectivorous. As I shall point out later, however, lizards show little or no discrimination with respect to the type of insect upon which they feed.

To substantiate my views as to the relationship between vegetation and saurian distribution, the occurrence of *Sceloporus g. graciosus* on the *Verbascum* association, on the *Juniperus* association, on the sand dunes about the squaw bush, on the gravel flats of the *Artemisia* association, and on the White Mountain sandy areas among the rabbit brush is to be noted. Likewise *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii* are equally abundant on the *Artemisia* association of the sandy and transition flats, and the fine-soiled *Artemisia* covered areas of White Mountain, and yet are lacking on the *Artemisia* gravel flats. Only in the instance of *Eumeces skiltonianus* can any correlation be made, but here, as has been pointed out, moisture is probably the dominant factor.

Vegetation, however, may play a secondary rôle in offering protection or in determining local abundance as in the squaw bush areas on the sand dunes where *Sceloporus g. graciosus* is very abundant because of the insect life about these bushes.

Food.—Although food must necessarily be a basic factor in the distribution of any animal, granted its presence in any form whatsoever, it seems to play little importance in the ecology of lizards. For the use of the following data I am indebted to Dr. A. G. Ruthven, who has not yet published the results of his studies on the food habits of several species of lizards.

It is to be understood first that lizards will eat almost any type of arthropod life, including ants, bees, wasps, grasshoppers, leaf bugs, and spiders; even scorpions are not uncommon in the stomachs of the larger species. If food is to be considered a primary factor in distribution, it must be assumed that a certain species of lizard restricts its diet to certain forms of life, and that it may be present wherever that suitable life occurs. Conversely, if that food is absent the lizard will be unable to inhabit the area. It can be shown that this is not true. First, the food of lizards varies during the year as indicated in Table III.[12]

TABLE III

1. *Sceloporus g. graciosus*—Gravel Flats

Food	July 9–11	August 10
Hymenoptera	70%	90%
Orthoptera	30%	100%
Coleoptera	100%	54%
Hemiptera	30%	....
Homoptera	10%	....
Arachnida	30%	....
Miscellaneous	10%	....

[12] The figures indicate percentage of total stomachs in which each type of food was present.

2. *Uta s. stansburiana*—Gravel Flats

Food	July 9–11	August 10
Hymenoptera	44%	60%
Orthoptera	11%	70%
Coleoptera	44%	60%
Hemiptera	11%	....
Homoptera	....	10%
Isoptera	56%	20%
Arachnida	11%	....
Miscellaneous	44%	20%

Although data to illustrate the point under discussion is presented above for only two forms, I have material at hand which shows the occurrence of the same result for the other species collected.

Second, the food of a single species of lizard is not necessarily the same in two different habitats on or about the same date as is to be noted in Table IV.

Despite the fact that grasshoppers make up the bulk of the food of *Sceloporus g. graciosus,* (the summer of 1931 saw a great emergence of these insects throughout the region as well as in the entire United States) striking differences in the other foods are readily recognizable.

TABLE IV

1. *Cnemidophorus t. tessellatus*

Food	Transition flats July 11	Sand flats July 13
Hymenoptera	27%	55%
Orthoptera	82%	77%
Coleoptera	27%	84%
Homoptera	9%	55%
Isoptera	....	31%
Larvae	73%	23%
Arachnida	55%	8%
Miscellaneous	9%	....

2. *Sceloporus g. graciosus*

Food	Sand dunes August 5	Gravel flats August 10
Hymenoptera	54%	90%
Orthoptera	100%	100%
Coleoptera	23%	54%
Hemiptera	15%	....
Homoptera	15%	....
Diptera	15%	....
Larvae	15%	....

Third, although similar food occurs on two habitats on or about the same date, the same species do not inhabit the two habitats as might be expected if food were a primary distributional factor. Table V shows that, in spite of the presence of similar food on two habitats, the two species of lizards noted do not inhabit both areas.

TABLE V

Food	*Sceloporus g. graciosus* *Verbascum* Association August 11	*Uta s. stansburiana* Cedar Mountain August 6–8
Hymenoptera	81%	85%
Orthoptera	94%	77%
Coleoptera	37%	39%
Hemiptera	13%	15%
Homoptera	....	4%
Miscellaneous	31%	12%

The fourth factor entering into the discussion of food, namely that adults and juveniles do not feed upon the same insects, is readily seen from Table VI. The specimens of *Uta s. stansburiana* were all taken on Cedar Mountain August 6–8.

These data seem to indicate a mechanical selection, that is, the juveniles are unable to cope with the larger insects and must necessarily confine their diet to smaller forms.

From the meager data presented it appears evident that the assumptions necessitated in considering food a primary

TABLE VI

Food	Adults	Juveniles
Hymenoptera	85%	85%
Orthoptera	77%	....
Coleoptera	39%	85%
Hemiptera	15%	8%
Homoptera	4%	15%
Arachnida	....	29%
Miscellaneous	12%	8%

distributional factor are false, and, as a result, there is no alternative but to believe that food, granted its presence in any form, plays little or no basic part in saurian ecology.

Enemies.—That enemies play an important part in saurian distribution cannot be doubted despite the lack of conclusive evidence. Hawks, snakes, parasites, and other lizards are probably the greatest enemies of the smaller forms, but I do not believe that these enemies can explain the presence of certain forms or can further account for the absolute absence of others. For instance, the absence of *Uta s. stansburiana* on the *Verbascum* association might possibly be attributed to the presence of numerous hawks; but the almost identical size and appearance of *Uta s. stansburiana* and *Sceloporus g. graciosus* makes it almost inconceivable that a hawk or a snake could differentiate between the two. As to cannibalism among lizards, I have found only one instance of this in a total of about 800 stomach examinations. I have no doubt, however, that in other areas cannibalism in *Crotaphytus* frequently occurs, as it has been noted by numerous workers. Parasites (the round worms and flat worms) are absent in lizards from this region, but I have found the former in lizard stomachs from other areas. Nothing is known of the micro-parasitic fauna which they may contain.

Life History.—It is interesting to note that the life history of lizards must necessarily be related to their distribution within very small limits during certain periods of the year.

Uta s. stansburiana on the sand-lava occupies the lava almost exclusively. The few specimens taken on the sand were juveniles of that year. It appears that the females probably leave the lava and go on the sand to deposit their eggs, after which they return to the lava. The young hatch on the sand and presumably later seek the lava. This same condition was noted on the Tabernacle lava flow, the young utas not infrequently were found on the ash beds rather than on the lava. It is possible that a short seasonal migration may occur among the adults, and that the peculiar distribution of newly-hatched young is not always indicative of the distribution of adults.

Colonization.—The factor of colonization, perhaps, adds more confusion to the distribution of the saurian fauna than any of the others. Despite the fact that a certain lizard is restricted to a definite type of habitat it does necessarily follow that it will occupy every suitable habitat. For instance, the distribution of *Sceloporus g. graciosus* is one of the most perplexing problems with reference to the saurian fauna of the region under discussion; it seems to be governed by no definite set of factors. Apparently it occupies any variety of loose soil. It is probably the most plastic form of the species collected. It is, moreover, quite possible that this lizard can inhabit practically all the habitats in the area, but has thus far only colonized the several areas upon which it was taken. This form seems to inhabit the areas closest to the mountains, that is, the area above the old glacial lake. From here it is spreading out on the now dry lake bottom, but thus far has not extended out on the desert to any great extent. The same principle of spreading may also be applied to *Crotaphytus wislizenii* and *Cnemidophorus t. tessellatus,* but the greater powers of locomotion and their restriction to definite habitats have enabled them to spread well out on the desert, where they inhabit the areas best suited to their existence. The abundance of certain forms in disconnected patches instead of a continuous distribution is probably the result of colonization brought about by special causes.

Summation of Distributional Factors

Having discussed the major factors resulting in the distributional scheme of the several forms, it is not out of place to sum up these factors as related to each of the various species within the Fillmore region.

1. *Crotaphytus collaris baileyi* (Stejneger)

This species evidently is limited to very rugged rocky areas such as are presented by the Ice Spring lava field. Its absence on the Tabernacle field is possibly owing to the factor of colonization, and it may possibly spread to this habitat some time in the future. I believe, however, that the Tabernacle field because of its less rugged nature has not presented a suitable habitat for this form.

2. *Crotaphytus wislizenii* Baird and Girard

The fine soils seem to be the controlling factor in the distribution of this species. Although it may occupy the same niche as *Cnemidophorus t. tessellatus,* I believe that it is probably better able to exist on the looser soils, such as drifting sands, whereas *Cnemidophorus* is restricted to the harder-packed areas.

3. *Uta stansburiana stansburiana* (Baird and Girard)

Except during certain stages of its life history, this form seems to be a coarse soil species of the drier areas. It is abundant wherever boulder clay and rock outcrops are present. It is a species similar in its choice of habitat to *Sceloporus elongatus* and *Crotaphytus c. baileyi,* but far more plastic. It apparently shuns water.

4. *Sceloporus elongatus* Stejneger

This species is an inhabitant of comparatively smooth rocky areas such as broad outcrops of rock. It differs from *Crotaphytus c. baileyi* in that it does not seem to occupy a very rugged area such as is presented by the Ice Spring lava field.

5. *Sceloporus graciosus graciosus* (Baird and Girard)

This small lizard is apparently the most plastic form taken in the area. It is a loose soil species inhabiting boulder clay and sandy areas. Sheer rock outcrops and lava areas of barren rock do not form a suitable habitat. It probably can inhabit any region in which *Uta s. stansburiana* and *Crotaphytus wislizenii* can live. Its discontinuous distribution in the area can be explained only by assuming that patchy colonization has taken place and that sometime in the future it will spread throughout the region.

6. *Phrynosoma douglassii ornatissimum* (Girard)

From the data at hand this species seems to occupy the mountains and foothills alone with little reference to soil or other factors. I have taken it at elevations of 9000 feet in the Pahvant Mountains.

7. *Phrynosoma platyrhinos* Girard

As contrasted with *Phrynosoma d. ornatissimum,* this species is restricted to the valley floor; it was not found either on the foothills or on the mountains proper. It seems to have no choice of habitat within the valley, except that it is most abundant in areas inhabited by *Uta s. stansburiana.*

8. *Cnemidophorus tessellatus tessellatus* (Say)

Like *Crotaphytus wislizenii* this form is an inhabitant of fine soils only, but unlike that species, which is not uncommon on the loose sands, it appears to be limited to the harder-packed areas.

9. *Eumeces skiltonianus* (Baird and Girard)

This species is probably normally restricted to the wooded slopes of the comparatively humid mountain regions. Its occurrence along Chalk Creek on the desert indicates that it is closely bound to moist areas.

Certain of the above forms seem rather closely bound to definite habitat types, but there is undoubtedly some plasticity present which enables the various species to exist in areas which do not offer the acme of their habitat preference. *Cnemidophorus t. tessellatus,* while apparently restricted largely to sandy areas, will under adverse conditions occupy an inferior area. For instance on the east side of the Ice Spring lava field, it was present on the ash beds, which are probably less advantageous to its life than are sandy areas. Nevertheless, in the absence of sand, it chooses to occupy the ash beds in preference to the rugged lava immediately adjacent. Thus each little ash island present in the center of the surrounding lava supports a colony of *Cnemidophorus.* The very definite restriction of certain species to certain habitats on White Mountain and on the Tabernacle lava field shows further that there is a definite choice of habitat among lizards. As has been noted, in the absence of the best habitat, the form will occupy that area closest in character to its favorite haunt. We may refer to this phenomenon as the principle of *forced selection of habitat.*

This principle may be illustrated with a series of tables in which are present habitats I–IV in an increasing series with reference to a single factor, such as soil, and by the use of species A–D each best suited to the habitat as shown below:

Habitats	I	II	III	IV
Forms	A	B	C	D

If Habitat I is removed, the following combination may result:

Habitats	II	III	IV
Forms	A B	C	D

If Habitat II is removed, it is not unlikely that the plasticity of species A will be forced too far and the habitat present will be too unfavorable to allow this species to exist. As a result, the following might exist:

Habitats	III	IV
Forms	B C	D

It is evident that the plasticity of certain forms may account for their presence in areas which superficially would seem too poorly fitted to the species. Furthermore, by the application of this principle it is possible to explain the distribution of a species which at first glance might appear illogical and without any governing laws.

The occurrence of relict forms presents another interesting phenomenon of saurian distribution in the Fillmore region. Although of little significant value, it is interesting to note the conditions within a changing environment. The area presenting this situation is the sand-covered lava on the west and southwest sides of the Ice Spring lava field. Apparently the lava was the first habitat and was probably occupied by *Crotaphytus c. baileyi* and *Uta s. stansburiana.* The sand flats at the same time probably supported *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii.* As time advanced the southwest wind gradually carried sand over the lava, although the lava remained the dominant feature. During this period the lava was probably occupied by *Crotaphytus c. baileyi* and *Uta s. stansburiana,* while a few specimens of *Cnemidophorus t. tessellatus* and *Crotaphytus wislizenii* lived on the larger sandy patches. The third stage of the development is present today. Under this condition the amount of sand has increased until it is dominant, and the lava is a secondary habitat. Conditions are such that *Crotaphytus c. baileyi* has disappeared, but *Uta s. stansburiana* still remains on the few small bits of lava and represents a relict form. *Crotaphytus wislizenii* and *Cnemidophorus t. tessellatus* have taken possession of the sand area at the present time. The fourth and final stage of the series will undoubtedly see the complete disappearance of the lava and its inhabitants, while the sand flat and its fauna will alone be present.

SUMMARY

1. The present study is based on collections of field data and specimens secured during the summer of 1931 near Fillmore, Utah.

2. The Pahvant Valley lies at an elevation of about 5100 feet in southwestern Utah and is made up of glacial Lake Bonneville bottom.

3. Twenty-two separate habitats were studied and nine different species of lizards were collected on them.

4. Numerous factors enter into the distribution of the several forms; of these soil morphology, moisture, and colonization seem to be the most important factors concerned with saurian distribution.

5. Lizards, although apparently closely associated with certain habitats, are plastic and may exist on less favorable habitats, choosing the more favorable; this choice may be termed *forced selection of habitat.*

PLATE I

FIG. 1.—*Artemisia* Association showing the conditions existing on the gravel and transition flats. The Ice Spring Craters lie in the background.

FIG. 2.—The *Artemisia* sand flats. The great abundance of rabbit brush is not typical, but the view shows the open conditions of vegetation present.

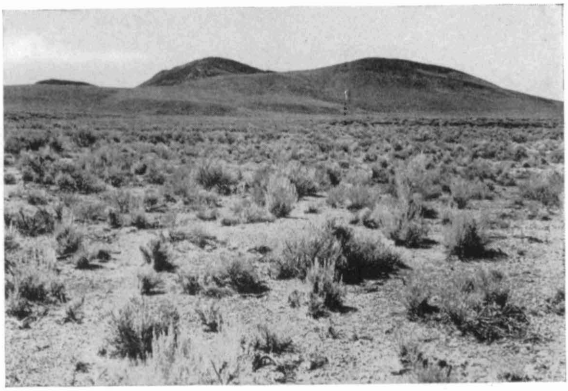


FIG. 1

FIG. 2

PLATE II

FIG. 1.—*Verbascum* Association along Chalk Creek. This habitat occupies only the very narrow strip along the creek which appears darker owing to the presence of grass. The typical gravel flats occupy the background.

FIG. 2.—A view across the *Juniperus* Association. Although this picture was not taken at Fillmore, it represents the conditions of vegetation existing there.

FIG. 1

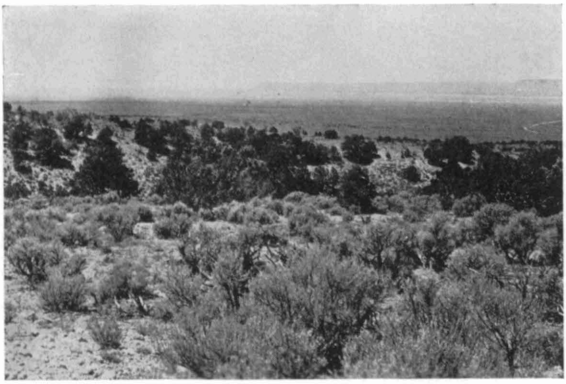


FIG. 2

PLATE III

FIG. 1.—A view across the sand dunes. The dunes proper are present in the left background, and the more heavily vegetated interdunal areas appear in the right background.

FIG. 2.—The lava on the Ice Spring Field. Note the very rugged condition completely devoid of vegetation.

FIG. 1

FIG. 2