

# Southwestern Animal Communities in the Late Pleistocene

by  
PAUL S. MARTIN

Geochronology Laboratories, University of Arizona, Tucson

A conspicuous feature of terrestrial communities in southern New Mexico and Arizona is their Mexican flavor. Outstanding among biogeographic problems of the Southwest is the history of this Mexican element. Within the Sonoran and Chihuahuan deserts, the desert grassland, the enclinal, and the mountain forests we encounter Mexican species or genera. Few of these species penetrate the Colorado Plateau of northern Arizona or central New Mexico. This observation is embodied in Lowe's term "Sub-Mogollon." It is illustrated by his distributional analysis in this symposium.

Those species with continuous ranges and non-relict distributions are of little help to the biogeographer. The gila monster, *Heloderma suspectum*, the black-tailed rattlesnake, *Crotalus molossus*, and the ground squirrel, *Citellus variegatus*, are found in the Mexican Plateau or its escarpment. They also range throughout lowland or both montane and lowland habitats in the Southwest. Presumably they occupy this region because of an adjustment to a climatic regime essentially arid, subtropical, and endowed with summer monsoon precipitation.

Of greater biogeographic interest are species confined to isolated habitats and thus to varying degrees discontinuous in their ranges. If the plants or animals concerned are not readily dispersed by wind, man, or other artificial means, their broken distribution may reflect a history of environmental change. In the case of desert fishes which inhabit small springs or headwater tributaries of extinct pluvial lake basins, the history of isolation is quite clear. It is the outcome of desiccation of pluvial lake drainages which occupied the Great Basin during the Wisconsin and earlier glacial periods (Hubbs and Miller, 1948).

<sup>1</sup> Contribution No. 10, Program in Geochronology, University of Arizona. This study was supported in part by a grant from the American Philosophical Society.

Isolated in the desert ranges, such as the Chiricahuas of extreme southeastern Arizona, relict populations of terrestrial vertebrates also seem to reflect past environmental change. To connect Chiricahua populations of *Sceloporus scularis*, *S. farrarii*, *Petromyscus difficilis*, and others (table 1) with related Mexican populations in the Sierra Madre would require a corridor of oak-pine woodland across intermontane divides presently supporting desert grassland and scrub.

It is difficult to establish limits on vertical and ecological distributions of the montane species, and we may anticipate some surprises. For example, *S. scularis*, the bunch grass lizard, is generally associated with yellow pine-bunch grass habitats above 7000 ft. However, its discovery at about 5000 feet in the Chiricahuas, at 4000 ft. in the Santa Catalinas (both in Gebbach, 1956), and at 4300 ft. in the Empire Valley, makes its separation from Mexican populations a matter of relatively slight climatic change.

Ecological study of the desert mountains began fifty years ago. Shreve's classic investigation of climate and vegetation zones in the Catalina Mountains revealed that no two species of trees or shrubs occupied the same vertical range (Shreve, 1915:111-112). In effect this conclusion anticipated the more elegant quantitative demonstration of species patterns and the continuum concept now foremost in vegetation analysis (McIntosh, 1958). Base level elevation, top elevation mass, bedrock composition, and slope all appeared crucial in determining the structural and floristic features of woodland and forest in the various desert mountains (Shreve, 1919, 1922; Blumer, 1910, 1911; Marshall, 1957: 31-32). Finally, regional climatic anomalies, presently under study by the Institute of Atmospheric Physics (see McDonald, 1956, for preliminary analysis) influence the lower limit of woodland and could explain the growth of trees, such as *Pinus leiophylla*, on certain ridges and slopes decidedly below their expected limits elsewhere (Marshall, 1957: 33).

The high montane faunas of the Southwest are poor in species. In the Chiricahuas, 70 species of terrestrial vertebrates (reptiles, amphibians, and small mammals) occur near the mountain foot at 5000 feet. Twelve occupy the top at 9500 feet (Fig. 1, table 2). This decline with altitude can be related to two features: first, the small area of mountain top forest, compared with extensive lowland habitats; second, the well-known effect of biotic depauperization with increase of elevation or latitude. We may infer a rough relationship between primary productivity and the number of species inhabiting communities along altitudinal or latitudinal gradients.

The desert mountains are not exclusively populated by southern, Mexican elements. There are Rocky Mountain species or subspecies which find their southern limits here. The mammals *Microtus longicaudus* in the Pinalenos, *Petromyscus maniculatus rufinus* in the Chiricahuas and Sacramentos, the salamander *Aneides hardyi* in the Sacramentos, the birds *Sitta canadensis* and *Hyllocichia guttata* in the Chiricahuas are suitable examples. In general the faunal pattern seems to match the floristic division noted by Shreve (1915: 40), i.e. Rocky Mountain elements are most obvious in the montane forests above 7000 ft. while the Mexican flavor is strongest in oak-pine woodland and grassland at lower elevations.

How can we explain the origin of montane relicts in the Southwest? There are at least three possible biogeographic hypotheses: (1) accidental arrival analogous to the colonization of

Oceanic islands; (2) Tertiary arrival with isolation during late Tertiary aridity; (3) one or several Pleistocene arrivals and post-glacial isolation.

The first of these suggestions carries some weight in terms of those trees and birds which enjoy a high dispersal potential. Marshall (1957: 67) favors it with regard to the Mexican oak-pine woodland birds in the Southwest. Gadow's observation (1930) on the colonization of the top of Volcanso Jorullo by pine (*Pinus montezumae*) is one of remarkably few cases in which the ability of a coniferous tree to cross an ecological barrier in a hurry has been demonstrated. In theory, the accidental arrival of montane reptiles and mammals on Jorullo and other isolated mountains would be much more difficult. In the absence of evidence that small, terrestrial vertebrates filter across major ecological barriers, it seems reasonable to interpret their distributions as the result of climatic change.

Turning to the paleoclimatic record, it is necessary to postulate Tertiary isolation in the face of the following: (1) very close taxonomic relationship between relict montane populations in the Southwest and Mexico (Bogert and Oliver, 1945:332-333); (2) Pleistocene pollen evidence of major climatic change in the Southwest, specifically the San Augustine Plains (Clusby and Sears, 1955) and Rampart Cave (Shuttler and Martin MS); (3) the extinct pluvial lakes and their Full-glacial correlation in the Great Basin (Broecker and Orr, 1958).

Such evidence does not exclude the probability of extensive and important Tertiary migrations. But it does make Tertiary biogeography irrelevant to the problem at hand, the isolation of the desert mountain biota. We may infer that Pleistocene climatic change was of sufficient amplitude to establish forest corridors between mountains in Mexico, the Southwest, and the Rockies.

The peculiar feature of the Southwestern biota, as I have stressed, is the large number of Madrean Mexican species which find their northern limits on montane forest populations. This is an inverted image of the classic Arctic-Alpine pattern. While it is reasonable to explain the distribution of *Sorex vagrans*, *Microtus longicaudus*, and *Aneides* as Full-glacial relicts (Findley, 1955; Murray, 1957), an inconsistency arises if we interpret the northern isolates of *S. scalaris*, *S. jarrovi*, and other Mexican animals and plants in such terms.

In brief, it appears to me that the montane Mexican element did not reach the Southwest at the same time as northern (Rocky Mountain) species. I would suggest that the most recent arrival of Mexican woodland elements is no older than the postglacial period. A rash guess would put the time of montane woodland interconnection at 3000 to 8000 years ago. This coincides with the Thermal Maximum of eastern North America and the Alti-thermal of the west. To generate a woodland corridor in this period may seem extremely improbable to those who associate climatic warming with drought. However, the special subtropical

monsoon circulation of the Southwest permits us to consider another element in the climate, the summer rains. Perhaps it would be helpful to restate the biotic evidence:

1. Marshall's sequence of montane vegetation types (1957: 32) shows that, as one proceeds southward into Mexico, pine-oak woodland and forest zones occur at lower levels.

2. Isolated mountains of the Southwest harbor a woodland biota derived mainly from the Mexican Plateau.

3. Parts of this biota are entirely confined to montane habitats, i.e. they include species unknown in the intermontane grassland or desert scrub.

4. Parts of this biota have relatively low accidental dispersal potential, i.e. terrestrial vertebrates.

5. Among the isolated montane populations studied closely, no important taxonomic differences have been reported in either reptiles and amphibians (Bogert and Oliver, 1945) or mammals (Hoffmeister and Goodpaster, 1954).

6. The present lower limit of the montane Mexican element is about 5000 feet, or roughly 1000 feet above the intermontane divides through northern Sonora, southern New Mexico, and southern Arizona. To obtain a continuous distribution of the Mexican montane element would require a climatic change sufficient to replace desert grassland and scrub, the present vegetation of the divides (Marshall 1957: Fig. 2.), with oak-pine savanna. This would not require a major climatic shift.

7. There appears to be a relationship between distribution of both lowland and montane Mexican biotas and the summer (Monsoon) rain circulation system of the Southwest.

If the northern limit of the Mexican element were determined by temperature alone we might expect individual species to occupy narrow vertical ranges at their northern outposts. However, both *S. scalaris* and *S. jarrovi* occur from 5000 to 10,000 feet in the Chiricahuas and Pinalenos respectively, the northern limits of these species. They occupy a wide altitudinal range here and scarcely exceed it on the Mexican Plateau.

The sudden depletion of Mexican elements, whether oaks (*Quercus arizonica*, *Q. emoryi*, and others), pines (*Pinus arizonica*, *P. leophylla*), lizards, snakes (*Crotalus pricei*, *C. willardi*), or mammals (*Peromyscus difficilis*, *P. truei*), and their extensive ranges in the summer-rain woodlands to the south suggests an obligate relationship, present and past, on a monsoon climate. Could these species have moved north into Arizona during the last Full-glacial interval of the late Pleistocene?

Pleistocene circulation is a matter of considerable meteorological speculation. I am indebted to J. E. McDonald for pointing out that, in subtropical latitudes, the most obvious effect of a continental ice sheet would be the elimination of the present midcontinent summer high-pressure center. This center is crucial in generating Monsoon summer rains in the Southwest. We may postulate that Southwestern pluvial lakes of Wisconsin age were

nourished almost exclusively by winter precipitation. While the Pleistocene climate would lower the ecological limits of montane species, permitting the entry of spruce and other Cordilleran species into the Sierra Madre, it should eliminate the summer rain biota from this area.

Study of recent weather records indicates that rainfall along the equatorial fringes is quite sensitive to changes in high-latitude circulation (Kraus, 1958). The warming of winter in high latitudes has allowed a gradual northward shift of subtropical cells with a rise in summer precipitation in central Mexico (Wallen, 1955: 61). On this basis it is possible to postulate increased summer rainfall near the boundary of the Monsoon system during past periods of high-latitude warming. Specifically, any climatic model for the thermal maximum in the postglacial period of the Southwest should allow for an increase in summer rainfall.

I am aware that such a bioclimatic theory conflicts with the more common view—that the alithermal, drought, and arroyo cutting are essentially synonymous. The fact that it is possible to construct a divergent model may encourage prehistorians and biogeographers to review the evidence.

The present ranges of montane animals and plants, viewed in terms of Pleistocene climatology, suggests that southeastern Arizona and southern New Mexico experienced invasion of Mexican woodland elements in postglacial time. Although they did not restrict such an invasion to the Alithermal, I find that Bogert and Oliver (1945: 332-333) reached essentially the same conclusion: "... the existence of populations belonging to the same species or subspecies that now are represented on mountaintops along the periphery of the deserts (but not in intervening territory) is interpreted as evidence for the belief that a moist period followed the last period of glacial cold." Perhaps pollen study of Late Pleistocene sediments in the Southwest will help to date the entry of montane Mexican animals and plants.

#### BIBLIOGRAPHY

- Blumer, J. C. 1910. A comparison between two mountain sides. *The Plant World* 13:134-140.
- ..... 1911. Change of aspect with altitude. *Ibid.*, 14:236-248.
- Bogert, C. M. and J. A. Oliver. 1945. A preliminary analysis of the herpetofauna of Sonora. *Bull. Amer. Mus. Nat. Hist.* 83:301-425.
- Broecker, W. S. and P. C. Orr. 1958. Radiocarbon chronology of Lake Lahontan and Lake Bonneville. *Bull. Geol. Soc. Amer.* 69:1009-1032.
- Chisby, K. H. and P. B. Sears. 1956. San Augustine Plains—Pleistocene climatic changes. *Science* 124:537-538.
- Findley, J. S. 1955. Speciation of the wandering shrew. *Univ. Kansas Publ., Mus. Nat. Hist.* 9:1-68.
- Gadow, H. 1930. *Jorullo, the history of the volcano of Jorullo and the reclamation of the devastated district by animals and plants.* Cambridge Univ. Press, 100 pp.
- Gehlbach, F. R. 1956. Annotated records of southwestern amphibians and reptiles. *Trans. Kansas Acad. Sci.* 59:364-372.
- Hoffmeister, D. F. and W. W. Goodpaster. 1954. The mammals of the Huachuca Mountains, southeastern Arizona. *Illinois Biol. Monographs* 24:1-152.
- Hubbs, C. L. and R. R. Miller. 1948. The Great Basin, II. The zoological evidence. *University of Utah Bull.* 38:17-166.
- Kraus, E. B. 1958. Recent climatic changes. *Nature* 181:666-668.
- Marshall, J. T. 1957. Birds of pine-oak woodland in southern Arizona and adjacent Mexico. *Pacific Coast Avifauna* No. 22:1-125.
- McDonald, J. E. 1956. Variability of precipitation in an arid region: a survey of characteristics for Arizona. *University of Arizona, Institute of Atmospheric Physics Technical Report* No. 1: 1-88.
- McIntosh, R. P. 1958. Plant communities. *Science*, 128:115-130.
- Murray, K. F. 1957. Pleistocene climate and the fauna of Burnet Cave, New Mexico. *Ecology* 38:129-132.
- Shreve, F. 1915. The vegetation of a desert mountain range as conditioned by climatic factors. *Carnegie Institution of Washington*, No. 217:1-112.
- ..... 1919. A comparison of the vegetational features of two desert mountain ranges. *Plant World* 22:291-307.
- ..... 1922. Conditions indirectly affecting vertical distribution on desert mountains. *Ecology* 3:269-74.
- Shutler, D., Jr. and P. S. Martin. MS. Pollen analysis of sloth dung from the Grand Canyon.
- Wallen, C. C. 1955. Some characteristics of precipitation in Mexico. *Geogr. Annaler* 37:51-85.

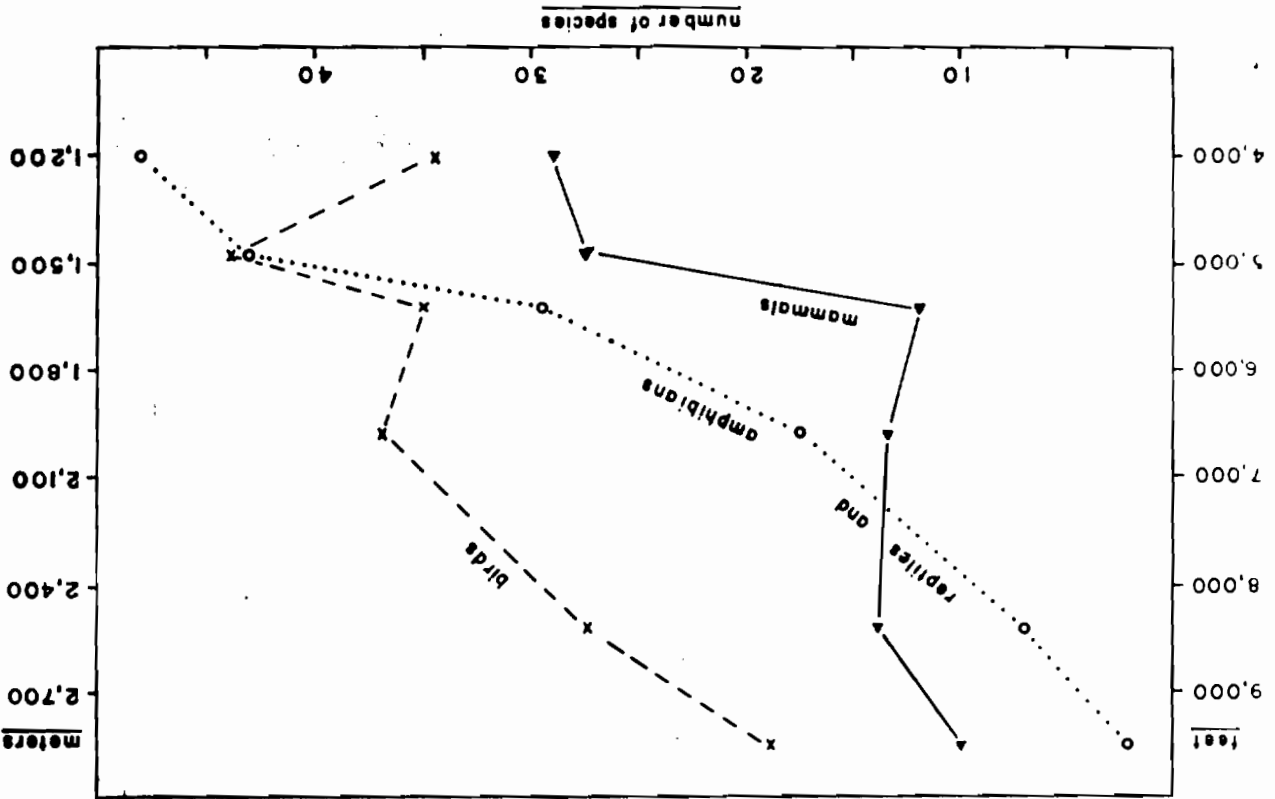


FIGURE 1.

Species-elevation curves for various small vertebrates in the Chiricahua Mountains: (1) passerine birds; (2) small mammals, Orders Insectivora, Rodentia, and Lagomorpha; and (3) reptiles and amphibians. Based on records listed in Table 2.

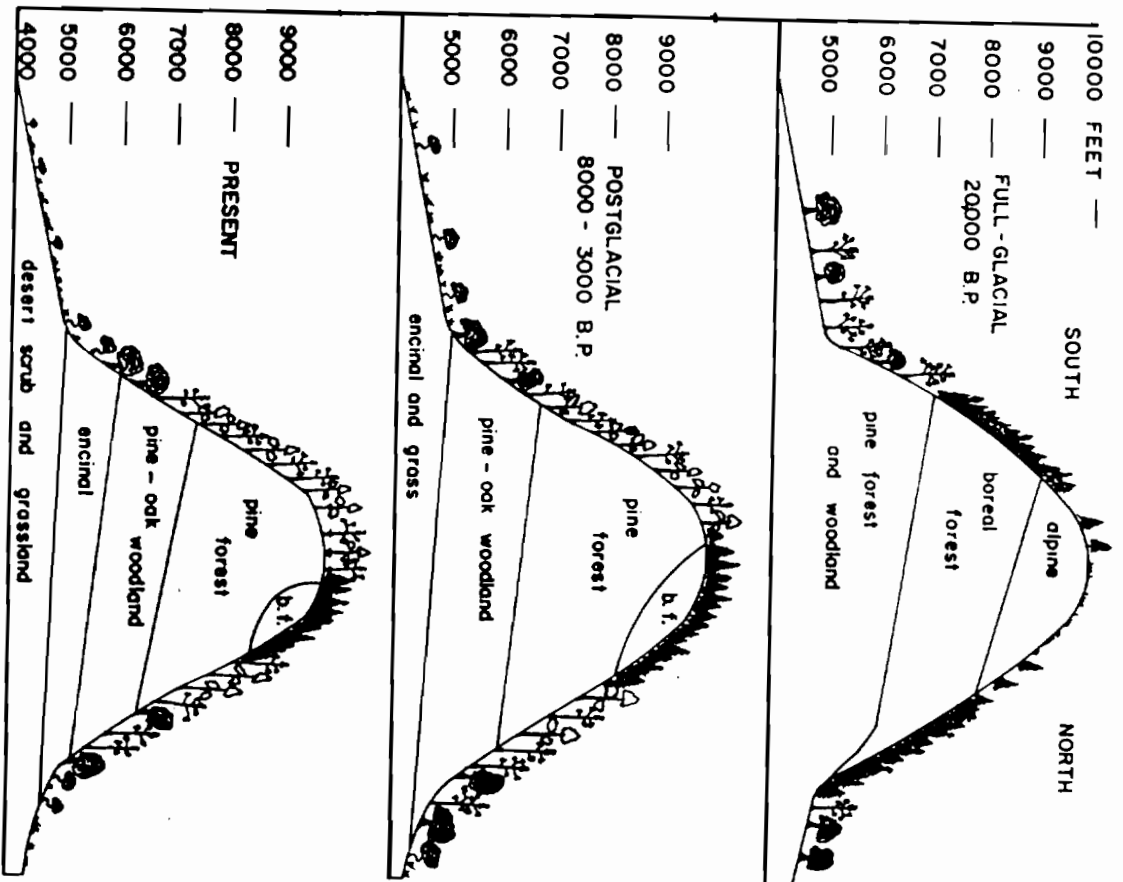


FIGURE 2.

Late Pleistocene changes in vegetation of a desert mountain at 32° north latitude. The last woodland-ancinal interconnection between ranges is considered of postglacial age. The position of vegetation zones at this time may have been subequal to that found presently at Nacori, 30° north latitude in northwestern Mexico (cf. Marshall, 1957: ).

Table II cont'd.

B. BREEDING PASSERINE BIRD DS.		1900	1901	1902	1903	1904	1905
21. <i>P. whiteheadi</i>		X	X	X	X	X	X
22. <i>P. swainsoni</i>		X	X	X	X	X	X
23. <i>Auriparus flaviceps</i>		X	X	X	X	X	X
24. <i>Parus rufus</i>		X	X	X	X	X	X
25. <i>Parus major</i>		X	X	X	X	X	X
26. <i>Parus major</i>		X	X	X	X	X	X
27. <i>Sitta carolinensis</i>		X	X	X	X	X	X
28. <i>Sitta carolinensis</i>		X	X	X	X	X	X
29. <i>Sitta carolinensis</i>		X	X	X	X	X	X
30. <i>Certhia americana</i>		X	X	X	X	X	X
31. <i>Troglodytes aedon</i>		X	X	X	X	X	X
32. <i>Thryomanes bewickii</i>		X	X	X	X	X	X
33. <i>Empidonax griseus</i>		X	X	X	X	X	X
34. <i>Caluscula mexicanus</i>		X	X	X	X	X	X
35. <i>Salpinctes obsoletus</i>		X	X	X	X	X	X
36. <i>Mimus polyglottus</i>		X	X	X	X	X	X
37. <i>Troglodytes aedon</i>		X	X	X	X	X	X
38. <i>T. aedon</i>		X	X	X	X	X	X
39. <i>Turdus migratorius</i>		X	X	X	X	X	X
40. <i>Hylocichla ustulata</i>		X	X	X	X	X	X
41. <i>Salix mexicana</i>		X	X	X	X	X	X
42. <i>Polioptila caerulea</i>		X	X	X	X	X	X
43. <i>P. caerulea</i>		X	X	X	X	X	X
44. <i>Regulus satrapa</i>		X	X	X	X	X	X
45. <i>R. satrapa</i>		X	X	X	X	X	X
46. <i>Polioptila caerulea</i>		X	X	X	X	X	X
47. <i>Labrus indociliana</i>		X	X	X	X	X	X
48. <i>Vireo huttoni</i>		X	X	X	X	X	X
49. <i>V. huttoni</i>		X	X	X	X	X	X
50. <i>V. olivaceus</i>		X	X	X	X	X	X
51. <i>V. olivaceus</i>		X	X	X	X	X	X
52. <i>V. olivaceus</i>		X	X	X	X	X	X
53. <i>Vermivora virginiana</i>		X	X	X	X	X	X
54. <i>V. virginiana</i>		X	X	X	X	X	X
55. <i>Dendroica auduboni</i>		X	X	X	X	X	X
56. <i>D. auduboni</i>		X	X	X	X	X	X
57. <i>D. auduboni</i>		X	X	X	X	X	X
58. <i>Geothlypis trichas</i>		X	X	X	X	X	X
59. <i>Cardellina rubrifrons</i>		X	X	X	X	X	X
60. <i>Cardellina rubrifrons</i>		X	X	X	X	X	X
61. <i>Passer domesticus</i>		X	X	X	X	X	X
62. <i>Sturnella magna</i>		X	X	X	X	X	X
63. <i>Icterus canadensis</i>		X	X	X	X	X	X
64. <i>I. canadensis</i>		X	X	X	X	X	X
65. <i>I. canadensis</i>		X	X	X	X	X	X
66. <i>L. pallasi</i>		X	X	X	X	X	X
67. <i>Melospiza cinerea</i>		X	X	X	X	X	X
68. <i>Prunella ludovicianus</i>		X	X	X	X	X	X
69. <i>P. ludovicianus</i>		X	X	X	X	X	X
70. <i>P. ludovicianus</i>		X	X	X	X	X	X
71. <i>Melanerpes formicivorus</i>		X	X	X	X	X	X
72. <i>Melanerpes formicivorus</i>		X	X	X	X	X	X
73. <i>Ceryle alcyon</i>		X	X	X	X	X	X
74. <i>Ceryle alcyon</i>		X	X	X	X	X	X
75. <i>Sitta carolinensis</i>		X	X	X	X	X	X
76. <i>Sitta carolinensis</i>		X	X	X	X	X	X

C. SMALL MAMMALS		1900	1901	1902	1903	1904	1905
1. <i>Onychomys leucogaster</i>		X	X	X	X	X	X
2. <i>Citellus pygmaeus</i>		X	X	X	X	X	X
3. <i>C. merriami</i>		X	X	X	X	X	X
4. <i>C. variegatus</i>		X	X	X	X	X	X
5. <i>Dipodomys deserti</i>		X	X	X	X	X	X
6. <i>Sciurus harrisi</i>		X	X	X	X	X	X
7. <i>Thomomys bottae</i>		X	X	X	X	X	X
8. <i>Perognathus merriami</i>		X	X	X	X	X	X
9. <i>P. merriami</i>		X	X	X	X	X	X
10. <i>P. flavus</i>		X	X	X	X	X	X
11. <i>P. intermedium</i>		X	X	X	X	X	X
12. <i>P. nitidus</i>		X	X	X	X	X	X
13. <i>P. apachus</i>		X	X	X	X	X	X
14. <i>P. pallidus</i>		X	X	X	X	X	X
15. <i>Dipodomys spectabilis</i>		X	X	X	X	X	X
16. <i>D. merriami</i>		X	X	X	X	X	X
17. <i>D. ordii</i>		X	X	X	X	X	X
18. <i>Reithrodontomys montanus</i>		X	X	X	X	X	X
19. <i>Reithrodontomys megalotis</i>		X	X	X	X	X	X
20. <i>R. nitidus</i>		X	X	X	X	X	X
21. <i>Perognathus fremontii</i>		X	X	X	X	X	X
22. <i>P. maculatus</i>		X	X	X	X	X	X
23. <i>P. boylii</i>		X	X	X	X	X	X
24. <i>P. frontalis</i>		X	X	X	X	X	X
25. <i>P. truei</i>		X	X	X	X	X	X
26. <i>P. manicus</i>		X	X	X	X	X	X
27. <i>P. albicollis</i>		X	X	X	X	X	X
28. <i>P. leucopus</i>		X	X	X	X	X	X
29. <i>Sitomys taylori</i>		X	X	X	X	X	X
30. <i>Onychomys leucogaster</i>		X	X	X	X	X	X
31. <i>O. borlindae</i>		X	X	X	X	X	X
32. <i>Sciurus harrisi</i>		X	X	X	X	X	X
33. <i>S. mollis</i>		X	X	X	X	X	X
34. <i>S. arizonae</i>		X	X	X	X	X	X
35. <i>Neotoma albigula</i>		X	X	X	X	X	X
36. <i>N. mexicana</i>		X	X	X	X	X	X
37. <i>Microtus merriami</i>		X	X	X	X	X	X
38. <i>Neotoma albigula</i>		X	X	X	X	X	X
39. <i>Perognathus merriami</i>		X	X	X	X	X	X
40. <i>Sciurus harrisi</i>		X	X	X	X	X	X
41. <i>Sciurus arizonae</i>		X	X	X	X	X	X
42. <i>Perognathus merriami</i>		X	X	X	X	X	X
43. <i>L. pallasi</i>		X	X	X	X	X	X
44. <i>Perognathus merriami</i>		X	X	X	X	X	X
45. <i>S. auduboni</i>		X	X	X	X	X	X
Total		29	27	28	28	28	28

TABLE I.

FOREST AND WOODLAND VERTEBRATES OF THE CHIRICAHUA MOUNTAINS

	4900'	5400'	6600'	8400'	8500'
R	* <i>Sceloporus scalaris</i>	X		X	?
E	* <i>S. jarrovi</i>		X	X	?
P	* <i>Eumeces callisephalus</i>	?	X	X	?
T	<i>Lampropeltis pyromelana</i>	?	X	X	
I	* <i>Crotalus pricei</i>		X	X	?
L	* <i>C. lepidus</i>		X	X	
E					
S					
M	<i>Batemania dorsalis</i>	X	X	X	X
A	* <i>Sturnus spachei</i>		X	X	
A	<i>Peromyscus boylii</i>	X	X	X	?
M					
M	<i>Pip. maculatus rufinus</i>		?	X	X
A	* <i>P. nasutus</i>			X	X
L	* <i>P. difficilis</i>			X	X
S					
	<i>Neotoma mexicana</i>		X	X	X
	† <i>Sorex vagrans</i>		?	?	X
	<i>Sylvilagus floridanus</i>		X	X	X

Species occupying lowland as well as montane habitats and those with a high dispersal potential (bats, birds) are excluded. Those with distribution centers in the Mexican Plateau are indicated by an asterisk (\*); those with distribution centers in the Rocky Mountains by a dagger (†).

Table II. Altitudinal records for vertebrates of the Chiricahua Mountains, Arizona. Definite literature or specimen records are marked "X", doubtful records or those expected on the basis of distribution in adjacent mountains are marked "?". The latter were counted as one-half in the total for each elevation.

SPECIES	A. REPUBLICAN AND ANTELOPE MOUNTAINS					B. BIRCHMOUNT PASSMOUNTAIN MOUNTAINS				
	4900'	5400'	6600'	8400'	8500'	4900'	5400'	6600'	8400'	8500'
1. <i>Sceloporus hammondi</i>	X									
2. <i>Neotoma mexicana</i>	X									
3. <i>S. cowlesi</i>	X									
4. <i>Bufo alvarius</i>	?									
5. <i>H. regilla</i>	X	X								
6. <i>H. arenicolor</i>	X	X								
7. <i>B. parvulus</i>	X	X								
8. <i>H. arenicolor</i>	?	X	X							
9. <i>H. arenicolor</i>										
10. <i>Rana pipiens</i>	X	X	X							
11. <i>R. canaliculata</i>	X	X	X							
12. <i>Rana pipiens</i>	X									
13. <i>K. snyderi</i>	X	X								
14. <i>Triturus cristatus</i>	X	X								
15. <i>Colonyt. variegatus</i>	X	X								
16. <i>Heteromys angustirostris</i>	X	X								
17. <i>Heteromys maculatus</i>	X	X								
18. <i>H. urax</i>	X	X								
19. <i>Callisaurus draconoides</i>	X	X								
20. <i>Crotalus scottii</i>	X	X								
21. <i>C. viridescens</i>	X	X								
22. <i>Sceloporus scalaris</i>	X	X	X							
23. <i>S. jarrovi</i>	X	X	X							
24. <i>S. cowlesi</i>	X									
25. <i>S. clarki</i>	X	X	X							
26. <i>S. maculatus</i>	X	X	X							
27. <i>Uta stansburiana</i>	X	X	X							
28. <i>U. stansburiana</i>	X	X	X							
29. <i>Phrynosoma douglasii</i>	X	X	X							
30. <i>P. cornutum</i>	X	X								
31. <i>P. modestum</i>	X	X								
32. <i>P. solarii</i>	X	X								
33. <i>Suberites obovatus</i>	X	X								
34. <i>E. allouphobus</i>	?	X	X							
35. <i>Crotalus cerastes</i>	X	X	X							
36. <i>C. cerastes</i>	X	X	X							
37. <i>C. uxoris</i>	X	X								
38. <i>Gerrhonotus blairi</i>	X	X								
39. <i>Lepidochelys dorsalis</i>	X	X								
40. <i>L. marulii</i>	X	?								
41. <i>Dactylopsalis regalis</i>	?	X	X							
42. <i>Heterodon nalisus</i>	?									
43. <i>Masticophis lateralis</i>	X	X	X							
44. <i>M. lateralis</i>	X	?								
45. <i>Silveria vivipara</i>	X	X								
46. <i>Silveria vivipara</i>										
47. <i>Elgmodon flavescens</i>										
48. <i>Ariton elegans</i>										
49. <i>Pipilo fuscus</i>	X	X	X							
50. <i>Lampropeltis pyromelana</i>	X									
51. <i>L. erula</i>	X									
52. <i>Rhombophallus lecontei</i>	X	?								
53. <i>Phrynosoma munitum</i>	X	X								
54. <i>Phrynosoma munitum</i>	X	X								
55. <i>Ptilopus canis</i>	X									
56. <i>Triturus cristatus</i>	X	X								
57. <i>Hypsiglena torquata</i>	?	X								
58. <i>Microtus eurysomus</i>	X	X								
59. <i>Sturnus clemens</i>	X	X								
60. <i>Crotalus pricei</i>										
61. <i>C. lepidus</i>	X	X								
62. <i>C. molokai</i>	X	X								
63. <i>C. scottii</i>	X	X								
64. <i>C. atrox</i>	X	X								
65. <i>C. cerastes</i>	X	X								
TOTAL	44	29	17	7	2					

Each species can not be expected at all sites with the same frequency. In other words, no single locality can be expected to yield all the species listed for that particular level. For example, *Microtus eurysomus* is a high altitude species, but it is also found at lower elevations near the higher peaks. The following figures are given in the latter as a first approximation to the relation in species with increase in elevation and [2] to indicate which species may be expected to occur at the Chiricahua Mountains. Those not occurring below 4900 feet may be in the latter category. It is obvious that isolation is common, and most of the fauna enjoy a continuous distribution between the mountains.