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Recommended Citation

Cockerell, T. D. A., "The Lower and Middle Sonoran Zones in Arizona and New Mexico" (1900). *Ca*. Paper 288.

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THE
AMERICAN NATURALIST

A MONTHLY JOURNAL DEVOTED TO THE
NATURAL SCIENCES IN THEIR
WIDEST SENSE

REPRINT

FROM

VOL. XXXIV, No. 400. APRIL, 1900



BOSTON
GINN & COMPANY
The Athenæum Press
1900

THE LOWER AND MIDDLE SONORAN ZONES IN ARIZONA AND NEW MEXICO.

T. D. A. COCKERELL.

For some years it has been a matter of controversy whether the Mesilla Valley (3800 ft. altitude) in New Mexico should be regarded as Lower Sonoran. The present writer classed it as Upper Sonoran, and later placed it in an intermediate zone, which he proposed to call Middle Sonoran. Dr. C. H. Merriam, on the other hand, regarded it as true Lower Sonoran, and so mapped it.

The writer, unfortunately, had never been able to study the true Lower Sonoran until his visit to Phoenix last year. This visit, while undertaken for other purposes, enabled him to reach some new conclusions, which are here set forth. While the discussion is largely technical, it is hoped that it will arouse some general interest, as the conclusions reached are of practical as well as theoretical interest.

We have in New Mexico and Arizona a number of fertile valleys, of which the Salt River and Mesilla Valleys are perhaps the most important. The Salt River Valley, in particular, is said to export more fruit than all the rest of Arizona combined. Now these valleys, between them, have to supply certain markets, and it is of the highest importance to each one that it should produce that which grows to a reasonable degree of perfection and finds a ready sale. If the valleys all belong in the same zone, they may be expected, speaking broadly, to produce the same crops, and it may be that in so doing they will overstock the market. But if there is in reality a great diversity in the agricultural conditions of the several valleys, so that they not only differ in detail but belong to different life zones,—this is a fact of the utmost practical importance, since it indicates that there may be such diversity in products as almost to avoid injurious competition. More-

over, if this diversity exists, it is of great value to the ranchman or orchardist to be made aware of it, since he will not then waste time and money by setting out plants which cannot be expected to succeed.

As a matter of fact, such problems as these have already been largely solved in the cultivated areas, by the experience — often tedious and expensive — of the residents. But they have not been solved for the areas which may yet be brought under cultivation, nor are the facts sufficiently accessible to residents in other states who expect to locate in the arid west. Yet again, even those residents who are satisfied with what their own locality will produce, are usually not acquainted with the possibilities of other districts, possibilities which affect them in so far as they affect the markets.

Last spring the writer had the pleasure of meeting Dr. Merriam at Washington, and at his suggestion made for him a list of the commoner trees and shrubs of the Mesilla Valley. Dr. Merriam, glancing over this, at once said: "With possibly one or two exceptions, these are *all* Lower Sonoran types." My investigations in the Salt River Valley have convinced me of the justice of this statement, and it may be said at once that, so far as the native flora is concerned, the Mesilla and Salt River Valleys may very well be placed in the same zone. The illustrative data given further on suggest more precisely the actual condition of affairs. Many of the plants which are abundant and conspicuous in the landscape are entirely the same, while others are so similar that they may be held to indicate rather the fact that we are three hundred and odd miles to the west of the New Mexico Valley than in a different life zone. In the list of insects common to the two valleys, also, we find many of the characteristic Mesilla Valley types, described as new from thence in recent years. The absolute differences, discussed under headings 3 to 5, are important in their way, and doubtless will be emphasized by further research; but it is at least questionable whether they indicate a different life zone, or, rather, whether they would indicate one if no other facts supported the division.

Turning now to the cultivated products, the conditions are

entirely different. The contrast, instead of being weak, is of the strongest possible kind; and if the valleys compared are not in different zones, then life zones have no meaning for the horticulturist. We thus arrive at this conclusion :

In the arid west the influences of temperature upon the cultivated, irrigated plants, derived from moister regions, are very much greater than upon the native plants or animals, which have become so adapted that they endure without harm enormous variations of heat and cold.

Hence it results that from the horticulturist's standpoint, the Middle Sonoran zone is a very real division, and belongs rather with the Upper than the Lower Sonoran. We may almost define the Middle Sonoran as a zone having the cultivated products of the Upper Sonoran and the native products of the Lower.

It will of course be understood that the data here given are only illustrative, and the time is not ripe for statistical tables. It will be a matter for future research to determine the exact details of the differences between the two zones. It is reasonably to be expected, however, that we may by patient study find native species of plants and insects which afford reasonably close indications of the horticultural zones, and thus enable us to decide the zonal position in advance of cultivation. Such decisions will be greatly assisted when we are in possession of more precise meteorological data, but unfortunately we know too little at present about the daily variations of temperature in the several localities where weather observations have been made, and the differences between the temperatures of adjacent localities.

Although Tucson is considerably higher than Phoenix, it is undoubtedly Lower, as distinguished from Middle, Sonoran. Oleanders, olives, Washingtonia and date palms, pepper trees, and a cultivated Parkinsonia were seen there; and Professor Toumey tells me there is a "hot pocket" some fourteen miles to the east, where orange trees are growing.

One circumstance which artificially emphasizes the horticultural distinction between the Mesilla and Salt River Valleys is, that in the latter it is possible to irrigate the higher levels at the side of the valley, while in the former only the bottom

CULTIVATED PLANTS OF SALT RIVER VALLEY AND THE
MESILLA VALLEY.

PLANT.	SALT RIVER VALLEY.	MESILLA VALLEY.
	(Minimum winter temperature, 32.2° F. ¹)	(Minimum winter temperature, 9° F.)
Date palm.	Does well.	Cannot stand the winter cold.
Washingtonia palm.	ditto.	ditto.
Olive.	ditto.	ditto.
Orange.	Does well at the sides of the valley.	ditto.
Almond.	Will bear a good crop if protected by smudges.	Cannot escape the frost in spring.
Peach.	Does well.	Does well.
Pear.	ditto.	ditto.
Apple.	Climate too hot and dry in summer.	ditto.
Fig.	Tree grows well without protection, but not successful as a crop on account of the dryness.	Killed to the ground in exposed places; grows well and fruits abundantly when protected by four walls.
Pomegranate.	Does well; much used for hedges.	Small plants growing in protected situations.
Grape.	Raisin and wine grapes do well.	Wine grapes do well.
Oleander.	Does well.	Winter too cold.
Pepper tree (<i>Schinus</i>).	ditto.	Not tried; winter doubtless too cold.
Sorghum.	ditto.	Does well.
Alfalfa.	Does well, but summers rather too hot and dry.	Grows to perfection.
Sugar beet.	Can be grown in the cool part of the year, Feb.-May.	Summers probably too hot for best results; Feb.-May too cold.
Irish potato.	Can be grown fairly well from Feb.-May.	Summers too hot; Feb.-May too cold.

lands are under ditch. In the cold weather the cold air settles in the lower lands, leaving the sides of the valley relatively warm, and hence it is that oranges can be cultivated with great success in the region about Ingleside, while they do not suc-

¹ From the observations made by Mr. W. G. Burns of the Weather Bureau at Phoenix it appears that the lowest temperature at that place in January, 1900, was 34° F., but on Feb. 7, 1899, the mercury fell as low as 24° F.

ceed commercially at Phoenix. The *Larrea* in the Mesilla Valley occupies only the higher levels, its lower limit, a little distance from the valley bottom, being as clean-cut as if it had been planted. But in the Salt River Valley the *Larrea* covers the whole area, and grows to a great size in the bottom lands, which are never so cold as to injure it. It is the desert land, once occupied by the *Larrea*, which has under irrigation been converted into the most flourishing orchards; and could the *Larrea* land of the Mesilla Valley be irrigated the results would doubtless be most gratifying.

These examples show us the value, on the one hand, of an exact knowledge of temperature conditions; and the fallacy, on the other, of mapping the temperature for the entire country from the observations made in a few widely scattered localities. Thus the temperature tables for Phoenix would not apply to Ingleside, nor those for Mesilla Park to the bench a couple of miles away. The writer has discussed the subject from his own standpoint, that of the fauna and flora; but he would not be understood to undervalue in any degree the knowledge of temperature in mapping life zones; all he would urge is, that for the proper mapping of zones on the temperature basis, we need a mass of information we do not possess, and are not likely to possess in the near future.

REPRESENTATIVE FACTS REGARDING THE NATIVE FAUNA AND FLORA.

(1) *Species Common to the Mesilla Valley and Salt River Valley.*

PLANTS.

<i>Perezia nana</i> Gray.	<i>Larrea tridentata</i> DC.
<i>Pluchea</i> (<i>Tessaria</i>) <i>borealis</i> Gray.	<i>Cladanthrix lanuginosa</i> Nutt.
<i>Pectis papposa</i> Harv. and Gray.	<i>Hoffmanseggia stricta</i> Benth.
<i>Aster spinosus</i> Benth.	<i>Populus fremonti</i> Wats.
<i>Helianthus annuus</i> L.	<i>Salix fluviatilis</i> Nutt.
<i>Baccharis glutinosa</i> Pers.	<i>Atriplex canescens</i> (Pursh) James.
<i>Verbesina encelioides</i> (Cav.) Gray.	<i>Datura meteloides</i> DC.

No attempt was made to catalogue the flora. The plants above cited are merely some of those which are so abundant and conspicuous as to give a character to the landscape.

Besides the identical species of *Baccharis* and *Atriplex*, the Salt River Valley has another *Baccharis* and two other species of shrubby *Atriplex* not found in the Mesilla Valley.

It seemed to me that the cottonwoods (*Populus fremonti*) of the Salt River Valley were not perfectly identical with those of the Mesilla Valley, but the species is presumed to be the same.

INSECTS.

<i>Colias eurytheme</i> Boisd.	<i>Aphalara suædæ</i> , Schwarz. MS.
<i>Pyrameis cardui</i> (L.).	(Tempe).
<i>Lycæna exilis</i> Boisd.	<i>Allorhina mutabilis</i> Gory.
<i>Libythea bachmani carinenta</i>	<i>Microcentrum retinervis</i> Burm.
(Cram.).	<i>Dicraneura cockerelli</i> Gill.*
<i>Synchlœ lacinia</i> Geyer (larvæ on	<i>Stictocephala festina</i> Say.
Xanthium and sunflower).	<i>Eriococcus tinsleyi</i> Ckll. (leaf-form).*
<i>Heliothis armiger</i> Hubn. (Buckeye).	<i>Phenacoccus helianthi</i> Ckll.*
<i>Asphondylia neomexicana</i> (Ckll.).	<i>Calliopsis coloradensis coloratipes</i>
<i>A. atriplicis</i> (Townsend).*	(Ckll.).
<i>Diplosis atriplicicola</i> Ckll.*	<i>Perdita asteris</i> Ckll.*
<i>Chilocorus cacti</i> (L.).	<i>P. salicis</i> Ckll.
<i>Drosophila ampelophila</i> Loew.	<i>Exomalopsis solani</i> Ckll. (Tempe).*
<i>Dorymyrmex pyramicus</i> Rog.	<i>Agapostemon melliventris</i> Cress.
(Buckeye).	(Tempe).
<i>Hesperotettix viridis</i> (Thos.).	<i>Halictus pseudotegularis</i> Ckll.
<i>Sphærophthalma donæ-anæ</i> Ckll.	<i>H. meliloti</i> Ckll.*
and Fox.*	<i>Prosapis mesillæ</i> Ckll. *
<i>S. foxi</i> Ckll.	<i>Mellisodes agilis</i> Cress.
<i>Coleophora suædicola</i> Ckll.	<i>Cockerellia albipennis helianthi</i>
(Tempe).*	(Ckll.).*
<i>Eromene (Euchromius) ocellæa</i>	<i>Aspidiotus juglans-regiæ albus</i>
(Haw.) Zell. (Buckeye).	Ckll.*
<i>Megilla maculata</i> (De Geer).	<i>Hormilia elegans</i> Scudder.*

The species and varieties marked with an asterisk were originally described from Mesilla Valley specimens.

I have included some species found at Buckeye, as, although this is not actually in the Salt River Valley, it is virtually part of the same region.

- (2) *Representative Species similar to, but not identical with, those of the Mesilla Valley.*

PLANTS.

Sphæralcea variabilis n. sp. — The common perennial *Sphæralcea* of the Salt River Valley, which at first sight might be taken for *S. lobata* Wooton, equally common in the Mesilla Valley. The leaves vary from $1\frac{1}{4}$ to over 3 inches long, and resemble in shape those of *lobata*, being quite long, with obtuse lateral lobes; but they average broader, are somewhat more regularly and finely crenulate, or the margins almost entire, and the living leaves have the surface, and especially the margins, much more wrinkled. The difference between the plants, as seen living, is sufficient to strike the eye, but it is a difference in average rather than absolute characters. There is, however, one character of greater value; the carpels of *lobata* are conspicuously cuspidate, whereas in *variabilis* they are rounded at the top, and bear no cusps. It may therefore be said that *variabilis* resembles *lobata* in its leaves, but *angustifolia* rather in its fruit. The basal portion of the carpels is very strongly reticulated, as in *lobata*. The flowers are as in *lobata*. This plant is here called a species, being about as distinct as the other members of its series — *angustifolia*, *lobata*, and *fendleri*; but it would be possible to regard *variabilis* as a race of *lobata*, or both as races of *fendleri*. *S. variabilis* was found freely blooming about Phoenix in October. It is not so tall a plant, on the average, as *S. lobata*.

Isocoma acradenia (Greene) Greene. — This is the common *Bigelovia* of the vicinity of Phoenix, exactly occupying the place taken in the Mesilla Valley by *I. heterophylla wrightii*. I had confused the Phoenix plant with *I. hartwegi*, but I found the real *hartwegi* (certified as such by Dr. Greene) abundant at Tucson, taking the place of *acradenia*. *I. acradenia* has the flowers of *hartwegi*, with the foliage (only smaller) of *heterophylla wrightii*.

Cucurbita palmata Watson. — Common in the Salt River Valley, taking the place of the Mesilla Valley *C. fœtidissima*.

Prosopis velutina Wooton. — The mesquite of Arizona, found at Phoenix, Mesa, Buckeye, Tucson, etc., is distinct from *P. glandulosa* Torrey, the mesquite of the Mesilla Valley.

Acacia greggii Gray. — Abundant in the Salt River Valley; much larger than the species of the Mesilla Valley.

Echinocactus lecontei (Engelm.) Toumey. — This barrel cactus takes the place of the Mesilla Valley *E. wislizeni* Engelm.; the latter, however, occurs at Tucson. *E. lecontei* is usually considered a variety of *E. wislizeni*, but when I saw it, it seemed to me distinct, and Professor Toumey tells me that it is a valid species.

Kallstrœmia grandiflora Torrey. — Very abundant in Phoenix ; a very beautiful flower, which ought to be in cultivation. It is allied to the much less conspicuous *K. brachystylis* Vail. of the Mesilla Valley.

K. grandiflora arizonica Ckll., with much smaller flowers and much shorter flower stalks, is also common at Phoenix.

K. californica (Wats.) Vail. det. Wooton, was found near Buckeye. It has never been seen in the Mesilla Valley.

Croton sp. — The common *Croton* of the Mesilla Valley is *C. neomexicanus*. At Phoenix I found in its stead a tall species closely allied to *C. texensis*, but less leafy at the top, and with very much denser pubescence on the leaves. No description has been found to fit it, and it may be undescribed.

Lycium gracilipes Gray. — Abundant in the Salt River Valley, taking the place of the Mesilla Valley *L. torreyi*.

INSECTS.

Sphærophthalma gloriosa (Sauss.) takes the place in the Salt River Valley of *S. pseudopappus* in the Mesilla Valley. This is a so-called "velvet-ant," covered with long white hairs.

(3) *Species entirely different from those of the Mesilla Valley.*

PLANTS.

Cereus giganteus Engelm. — The giant cactus.

Holacantha emoryi Gray. — The crown of thorns.

Parkinsonia torreyana Wats. and *P. microphylla* Torrey. — The two species of palo verde.

Hetherotheca subaxillaris (Lam.) B. and R. — A yellow flowered composite, very abundant throughout the Salt River Valley. It is doubtless native, as I found two new bees (*Perdita mellina* Ckll. and *P. heterothecæ* Ckll.) specially attached to it.

The above are conspicuous in the landscape ; no attempt was made to catalogue the less conspicuous forms.

SCALE INSECTS.

It is an interesting fact that allied or identical plants in the two regions under consideration are in certain cases infested by entirely different scale-insects. Thus :

The *Larrea* in the Salt River Valley is infested by *Dactylopius irishi* Ckll. and *Tachardia larreæ* Comst., while the same plant in the Mesilla Valley produces *Dactylopius steelii* Ckll. and Towns., *Icerya rileyi* Ckll. and *Eriococcus larreæ* Parrott and Ckll.

The mesquite (*Prosopis velutina*) in the Salt River Valley is infested by *Xerophilaspis prosopidis* Ckll. and *Diaspis arizonicus* Ckll. ; at

Tucson it produces *Aspidiotus candidulus* Ckll., *Toumeyella mirabilis* Ckll., *Eriococcus quercus toumeyi* Ckll. and the *Xerophilaspsis*. The mesquite (*Prosopis glandulosa*) of the Mesilla Valley produces *Icerya rileyi* Ckll. and *Dactylopius prosopidis* Ckll. The mesquite (*Prosopis juliflora*) of Jamaica produces *Icerya rosæ* R. and H. and *Dactylopius virgatus* Ckll.

(4) *Species of the Mesilla Valley absent from the Salt River Valley.*

A curious case is that of the mistletoe of the cottonwood, *Phoradendron macrophyllum* (*Phoradendron flavescens* var. *macrophyllum* Engelm., *Bot. Wheeler Surv.*, p. 252) which is abundant and destructive on the *Populus fremonti* of the Mesilla Valley, but does not go up the valley of the Rio Grande as far as its host, or down into the Salt River Valley, where the same cottonwood abounds. It is not that it is absent from the Gila basin, for it was first described from the Gila and Bonita Rivers. Its absence from the Salt River Valley is confirmed by Professor McClatchie; and, indeed, were it present it could not escape observation. The bag-worm (*Oiketicus townsendi*) of the Mesilla Valley, although common at Tucson, was not observed in Salt River Valley.

(5) *Ants of Buckeye and the Mesilla Valley.*

A series of ants collected at Buckeye was kindly determined for me by Mr. Ernest André, and it appears that the ant-fauna of this region has little in common with that of the Mesilla Valley, as witness the accompanying lists :

MESILLA VALLEY.

<i>Camponotus maculatus maccooki</i> Forel.	<i>Pogonomyrmex barbatus</i> Sm. (race <i>fuscatus</i>).
<i>C. marginatus decipiens</i> Emery.	<i>P. badius</i> Latr.
<i>Formica subsericea subpolita</i> Mayr.	<i>P. californicus</i> Buckl.
<i>Forelius maccooki</i> Forel.	<i>Monomorium minutum</i> Mayr.
<i>Lasius umbratus bicornis</i> Foerst.	<i>M. pharaonis</i> L.
<i>Dorymyrmex pyramicus</i> Rog.	<i>Pheidole morrisi</i> Forel.
<i>Aphaenogaster albisetosa</i> Mayr.	<i>Solenopsis geminata</i> Fabr.
<i>A. cockerelli</i> André.	<i>Cremastogaster laeviuscula clara</i> Mayr.
<i>Tapinoma anale</i> André.	<i>Labidus harrisii</i> (Hald.).
<i>T. sessile</i> Say.	
<i>Atta</i> (<i>Trachymyrmex</i>) n. sp.?	

BUCKEYE.

<i>Atta versicolor</i> Perg.	<i>Dorymyrmex pyramicus</i> Rog.
<i>Cremastogaster atra</i> Mayr.	<i>Prenolepis vividula guatemalensis</i> Forel.
<i>Aphaenogaster pergandei</i> Mayr.	

