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CLIMATOLOGY OF TINAJAS ALTAS, ARIZONA:[1] *PRELIMINARY REPORT.*

THE STATION.

TINAJAS ALTAS (colloquially, Tinaxaltas; a Spanish term commonly rendered 'high tanks') may be described as a locality in extreme southwestern Arizona about forty miles east of the mouth of Rio Colorado and three miles north of the Mexican boundary. The name denotes a number of tinajas, or tanks ('water-pockets' in the vernacular of western America, 'pot-holes' in British geology), found in the bottom of a precipitous gorge on the northeastern side of Sierra Gila, a granite range extending southeastward from Gila City and terminating in Sonora a few miles south of the international boundary. The tanks were well known to the aborigines in prehistoric times, and have been known to white men since Padre Kino passed by them in that notable expedition of 1699–1701 which led to the rediscovery of Rio Colorado and the subsequent mapping of the country beyond as a peninsula rather than an island. While California was a province of Mexico, one of the main overland routes connecting it with the capital

[1] Published by permission of the chief of the U. S. Weather Bureau.

city touched Tinajas Altas as the sole permanent 'water' in the 125 hard miles between Rio Sonoyta and Rio Colorado—*i. e.*, in 'El Camino del Diablo' which in the more fertile valleys of California became 'El Camino Real'—and ever since the supply has been deemed unfailing; though singularly enough the water was practically exhausted in the summer following the exceptionally wet winter and spring of 1905, seemingly for the reason that the unusually prolonged and gentle precipitation served rather to fill the tinajas with sand than to sweep them clean and leave them brimming, as do the ordinary rains of the region.

By trail the locality is 75 miles southeast of Yuma, by air-line 15 or 20 miles less; it is 35 or 40 miles south of Gila River at its southerly bend east of Gila City, and 40 or 50 miles north of the nearest shores of Gulf of California; the closest habitations are at the Southern Pacific station Wellton, some 30 miles away in an air-line, and more by any practicable route—there is no road.

The altitude of the lowest tinaja and the adjacent mesa on which the station was established is about 1,400 feet; the contiguous gorge-walls and peaks rise precipitously 750 feet, and some of the neighboring crests 2,000 feet higher (the United States and Mexican boundary survey maps locate near-by peaks above the 800-meter contour line). Albeit a low range, Sierra Gila is notably rugged and conspicuously sterile —it is, indeed, one of the most utterly barren mountain masses in America. From its western base a sandy plain, broken by a few low buttes and ranges, stretches southwestward to the Cocopa Mountains far beyond the Colorado, inclining southward to the gulf; east of it lies a smooth valley-plain seven to twelve miles wide, bounded beyond by a parallel granite range—Sierra de la Cabeza Prieta. Still further eastward lie other more or less parallel ranges with intervening valleys; the Mohawk Range, Sierra Pintada, Sierra Pinecate (on the Sonora side), Ajo Mountain, Sierra Quijotoa and the Baboquivari being the more conspicuous elevations about which summer clouds are wont to gather.

The station equipment comprised (1) a weather bureau instrument shelter of the type used by 'volunteer observers' (mounted on a base about four feet high, improvised from the packing-crate and grub-boxes and guyed with baling-wire); (2) maximum and minimum thermometers; (3) a sling psychrometer; (4) a barograph (supplemented by a fine aneroid of French make); and (5) an improvised rain gauge.

OBSERVATIONS AND GENERALIZATIONS.

Observations were made and recorded twice daily, viz., 8 A.M. and 8 P.M. local time; the hour of observation being advanced some minutes (in accordance with suggestions growing out of hourly observations during the earlier days) to counterbalance the effect of the local topography: for the station occupied a deep gorge opening east-northeastward in which the rays of the morning sun were concentrated by reflection, while the afternoon sun set behind Sierra Gila at 4 to 4:15 P.M. The outfit reached the ground and the instruments were unpacked during the afternoon of May 20, and experimental observation began on the morning of May 21 and was well under way on May 23;[2] the observations were continued until after sunset August 28, when the station was hastily

[2] In the transcripts of the records and averages first made, the period of systematic observation was reckoned as beginning with May 23; but on finding that the total period of observation was exactly one hundred days reckoned from and including May 21, the experimental record was afterward incorporated.

dismantled and the equipment transferred during the night to Wellton *en route* to Yuma.

The observations comprised pressure (determined by barograph and aneroid), temperature, humidity, wind, precipitation and cloudiness.

The barograph was used in accordance with a courteous suggestion by Sumner Hackett, U. S. weather observer at Yuma, in the hope that its record might throw light in the persistent lows of the California Gulf region. This record has not yet been compared and discussed.

The wind observations were rendered practically worthless by local conditions; the atmosphere in the gorge was habitually disturbed by dust whirls drifting in from the plain with intensity rapidly increasing as they caught the rock-warmed air-volume between the canyon walls, so that even the pressure was rendered unsteady (in one case a single whirl of momentary duration caused the barograph pen to record a change in pressure of over twenty feet); while the arrangement of neighboring peaks and precipices so disturbed the general air currents that their direction could seldom be determined confidently without a journey of two or three miles eastward on the plain, or a three-hours' climb up the granite precipices and peaks.

From the beginning of experimental observation on May 21, the temperature records (both of the maximum and minimum and of the wet and dry bulb thermometers) seemed notable by reason of a relatively low diurnal range—a range considerably less than that previously noted by the station agent in connection with geologic and ethnologic work in Nevada, Sonora and southern-central Arizona. The minitude of the range, indeed, awakened a suspicion of inaccurate reading and led to the above-noted delay of two days in beginning the more formal record transmitted to the observer at Yuma; it also led to a series of experiments with coverings for the wet bulb of the psychrometer, resulting in the adoption of a somewhat thicker and more spongy covering and a longer period of swinging than more humid climates require. Before the middle of June, however, the record developed such consistency as to establish the general accuracy of the observations. The accompanying Table I., transcribed from the original field-sheets, illustrates the lowness of diurnal and general ranges in temperature and also in moisture—including rain as well as cloudiness (expressed in tenths of total sky estimated for the visible and inferred for the invisible portions)—during the one hundred days from May 21 to August 28. As shown by this table, the extreme thermometric range during this period was but 62.8°, the range

TABLE I.—TEMPERATURE AND MOISTURE EXTREMES.

Term.		Temperature.			Moisture.							
		Self-reg. Therm's.			Dew-point.			Relative Humidity.			Rain (in.).	Cloudiness.
		Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.		
May (21–31)	A. M.	88.4°	**54.6°**	33.8°	54.0°	42.0°	**12.0°**	62%	25%	37%	0.00	7
	P. M.	96.0	54.6	**41.4**	48.0	35.5	12.5	56	18	38	.00	2
June	A. M.	97.4	65.4	32.0	52.0	25.0	27.0	37	10.5	26.5	.00	7
	P. M.	105.9	77.1	28.8	52.0	17.0	35.0	32	6	**26**	.00	0+
July	A. M.	109.0	73.6	35.4	68.5	21.0	47.5	63.5	6	57.5	T	8
	P. M.	**117.4**	79.7	37.7	62.0	**12.0**	**50.0**	54	4	50	T	3
Aug. (1–28)	A. M.	102.0	73.9	**28.1**	**72.0**	29.0	43.0	**75**	8	**67**	.12	10
	P. M.	110.2	77.4	32.8	66.0	40.0	26.0	48	12	36	.00	8
Extreme ranges.				62.8			60.0			71		

in dew-point only 60°, and that in relative humidity only 71 per cent.—ranges not infrequently exceeded within twenty-four hours in certain desert localities.

As the record developed, establishing a persistently low diurnal range in temperature with consistent values for moisture, special attention was turned to the monthly means. Semi-daily means (including rain and also cloudiness expressed in tenths and fractions) are given in the accompanying Table II. As shown by this table, the approximate mean diurnal ranges in temperature varied from 11.4° to 15.9°, the mean depression of the wet-bulb thermometer from 15.2° to 29.2°, and the relative humidity from 15.9 per cent. to 40.6 per cent.; ranges suggesting a moderately humid rather than a distinctively arid climate.

Even more striking than the semi-diurnal means are the daily means summarized by months; largely transcribed from the monthly records, these are recapitulated in Table III. As indicated by the table, the mean diurnal range for the one-hundred-day period varied between 20.1° and 24.5°; and it may be noted that the greatest and least daily ranges in June were 30.4° and 13.4°, the absolute range for the month being 40.5°, while the corresponding values for July were, respectively, 28.0°, 13.9° and 43.8°, and for August 25.0°, 13.0° and 36.3°. The psychrometric and humidity means are consistent, and the ranges correspondingly low. (The average dew-point and relative humidity computed from the means in the table are, of course, not strictly accurate; the values corresponding to the means of 88.9° for the dry-bulb and 64.5° for the wet-bulb thermometer would be respectively 49° and 25 per cent.)

Although deemed of only moderate value, the records of precipitation and

TABLE II.—TEMPERATURE AND MOISTURE MEANS.

Term.		Temperature.						Moisture.			
		Self-Reg. Therm's.			Psychrometer.			Humidity.		Rain (in.).	Cloudiness.
		Max.	Min.	Range.[3]	Dry Bl.	Wet Bl.	Deprsn.	Dewp't.	Rel. H.		
May (21–31)	A. M.	**78.5°**	**64.4°**	14.1°	**73.4°**	**58.2°**	**15.2°**	46.8°	**40.6%**	0.00	1.2
	P. M.	86.2	70.5	15.7	76.0	59.0	17.0	45.5	36.6	.00	.5
June	A. M.	90.6	74.7	**15.9**	83.8	59.4	24.4	38.8	21.6	.00	.4
	P. M.	98.9	86.1	12.8	89.6	60.4	**29.2**	**34.4**	**15.9**	.00	.4
July	A. M.	94.8	80.0	14.8	90.5	66.4	24.1	49.1	29.1	T	1.0
	P. M.	**102.2**	90.1	12.1	93.8	66.0	27.8	45.9	22.6	T	.4
Aug. (1–28)	A. M.	94.6	81.7	12.9	90.7	**69.8**	20.9	**57.3**	37.3	0.04	1.0
	P. M.	101.8	**90.4**	**11.4**	**94.0**	69.6	24.4	54.8	28.5	.00	1.2

TABLE III.—TEMPERATURE AND MOISTURE SUMMARIES AND AVERAGES.

Term.	Days.	Temperature.							Moisture.			
		Self-registering Therm's.				Psychrometer.			Humidity.		Rain (in.).	Cloudiness.[5]
		Max.	Min.	Range.	Mean.	Dry Bl.	Wet Bl.	Depr.[4]	Dewp.	Rel. H.		
May (21–31).	11	**86.2°**	**64.1°**	22.1°	**75.1°**	**74.7°**	**58.6°**	**16.1°**	44.8°	**38.6%**	0.00	0.6
June.	30	98.9	74.4	**24.5**	86.6	86.7	59.9	**26.8**	**36.6**	**18.5**	.00	.23
July.	31	**102.2**	80.0	22.2	91.1	92.1	66.2	25.9	47.5	25.9	T	.7
Aug. (1–28).	28	101.8	**81.7**	**20.1**	**91.7**	**92.3**	**69.7**	22.6	**56.0**	32.9	.002	1.2
Averages for	100	99.3	77.0	22.3	88.2	88.9	64.5		46.5	27.1	.001	.67

[3] Approximate values taken from means in this table.

[4] Approximate values taken from means in this table.

[5] Taken from monthly summaries.

cloudiness are consistent with those of temperature, and are hence of some significance. The total precipitation of the period comprised 0.11 inch on the morning of August 9 and 0.01 inch on the morning of August 27, as measured at the camp within a few yards of the instrument shelter. On both occasions the amount varied greatly in both vertical and horizontal directions, the zones of precipitation being narrow and the greater part of the initial volume being evaporated in the lower atmospheric strata—indeed, but a small part of the rain precipitated from the dark bases of the cumulus clouds ever reached the ground. In the heavier precipitation of August 9 the rain diminished to a trace within 300 yards down the arroyo and some 60 feet below the level of the station, while on the gorge walls 300 feet south of and 200 feet above the station the fall was probably between 0.20 and 0.30 inch.[6]

The value of the cloud observations was impaired by the smallness of the visible sky, only about 50 per cent. of the total being in sight at the station. From E. to N. 30° E. the horizon was broken only by Sierra de la Cabeza Prieta some ten miles away, and the still remoter Mohawk Range; thence by north to west the skyline averaged some 20° above the horizontal, while the mean altitude of the southerly sky line was over 30°. Accordingly, stratus and other clouds toward the western and southern horizons were seldom seen. Some 90 per cent. of the clouds observed gathered or drifted in northerly directions over Cabeza Prieta and other ranges east of the station; and but few cirrus and still fewer cumulus clouds formed or floated over Tinajas Altas and the neighboring portions of Sierra Gila. In general the cloudiness diminished somewhat from the middle of May to near the end of June and then increased during July and August (as indicated in Table II.); in general, too, the cloudiness was less in the evening during the earlier part of the period, with a tendency toward becoming greater in the evening in the later part. Concurrently with the cloud and rain observations a record was kept of thunder, lightning and haze, which were lacking in May and June, fairly frequent in later July, and quite frequent in August—indeed during the later half of August more or less distant thunder was heard almost every afternoon and sheet or flash lightning was seen during most evenings. By far the greater portion of the located thunder and over 75 per cent. of the visible lightning occurred in the east, *i. e.*, over Cabeza Prieta and other ranges; and at least a dozen—perhaps a score—of rainfalls were seen in the same quarter. Occasional views were had of the entire horizon from the crests and peaks of Sierra Gila; and while clouds were sometimes seen over the valley of Rio Colorado and the Cocopa Mountains beyond, these only confirmed the observations made at the station which served to locate a zone of precipitation passing in a northerly direction over Cabeza Prieta and neighboring ranges, *i. e.*, from some ten to fifty or one hundred miles further eastward than Tinajas Altas and Sierra Gila. There were no observations on dew, for the sufficient reason that throughout the entire period there was none; the greatest relative humidity at the hours of observation was but 75 per cent. and the maximum probably fell below 90 per cent. even in the feeble rains—during which it was evident that evaporation from

[6] This rainfall, especially on the rocks above the level of the station, served to partly refill the tinajas and so prolong the maintenance of the station; the evening before its occurrence the total quantity of water remaining was estimated at five gallons, or four days' supply, with an extra gallon for the walk to Wellton.

fabrics, etc., proceeded nearly as rapidly as wetting. Similarly, no observations were recorded on mirages or other phenomena of refraction, of which there was a notable dearth; on a few occasions of light dust daze due to strong winds over the crests and broader valleys, Sierra de la Cabeza Prieta appeared magnified and brought near, though its angular altitude (determined by sighting over fixed points in rocks adjacent to the instrument shelter) did not vary perceptibly; and during the entire one hundred days not a single mirage of the type so common a few score miles further eastward was seen. In a word, the atmospheric phenomena in general, like the temperature records, denoted a condition of striking steadiness or stability during the period of observation.

Tinajas Altas was chosen primarily as a site for a study of light and its effects on desert organisms; and after unsuccessful efforts to obtain a satisfactory photometer a series of determinations of the intensity of light by means of a simple exposure meter was planned. The record is of little value, partly because the paper used in the apparatus is sensitive to moisture as well as light, but in the inverse direction, so that the time of coloration gave merely an inseparable measure of aridity and luminosity. In general the record indicates a light intensity twice or thrice that of Saint Louis—a measure probably worth less than the common experience of photographers that in the arid region given plates ordinarily require but one half to one fifth of the exposure needed in humid regions.

COMPARISONS.

Tinajas Altas was selected as a desert station, yet the records were found notably discordant with incidental recollections of and notes on climate in the more desert districts of Nevada, southern-central Arizona and central Sonora. The absolute and mean maximum temperatures were decidedly lower and the diurnal thermometric range much lower, while the mean temperature was rather higher and the absolute and mean minima much higher than anticipated; concordantly, the moisture (dew-point and relative humidity) was both higher and much less variable than previous experiences indicated as probable or even possible—it is, indeed, a striking fact that the entire range of relative humidity during a period of one hundred days should be no more than 71 per cent., and it is even more striking that, despite the considerable average humidity, the dew-point was never reached during the one hundred-day period. In short, while Sierra Gila and the adjacent plains are typical if not utter deserts, the climate of Tinajas Altas impresses the observer as subhumid rather than arid—and this despite the limited precipitation.

As the record assumed form during July and August, definite comparisons were made with other stations in Arizona, especially with the cooperative (until recently known as volunteer) stations in the western division of the territory; this being made easy through the monthly records issued by the 'Arizona section of the climate and crop service of the Weather Bureau' published by authority of the Secretary of Agriculture, under the direction of the chief of the Weather Bureau, by Lewis N. Jesunofsky, section director. Contrary to a widespread impression (first produced when Fort Yuma was the sole station in its region), these reports show that Yuma is (at least during summer) by no means the hottest station in the country—indeed, with the single exception of the mountain station Kingman, its temperature is both lower and more equable than that of any other station in western Arizona: Aztec, Mohave, Mohawk, Parker and Sentinel, with several other points in the southern

division, giving higher extremes, ranges and means. The temperature records of southwestern Arizona (including Tinajas Altas) during the summer of 1905, in fact, fall into three groups or classes, viz: (1) the mountain class, represented by Kingman; (2) the interior plains class, comprising Aztec, Mohave, Mohawk, Parker and Sentinel; and (3) what may be called the Gulf class, represented by Yuma and Tinajas Altas. Denoted by their more striking features, these may be considered, respectively, the cool, the hot and the equable varieties or phases of southwestern Arizona's summer climate. These are illustrated in the accompanying Table IV., compiled chiefly from Jesunofsky's report for July;[11] two classes. The classes of climate or their districts might be defined also by moisture (vapor, precipitation, or both) though they intergrade; in general it may be said—though the qualifying factors are many—that the vapor-content decreases and the precipitation increases east and northeast of the gulfward zone represented by Yuma and Tinajas Altas.

TABLE IV.—CLIMATAL TYPES OF WESTERN ARIZONA. (Defined by Temperature Records for July, 1905.)

Station.		Altitude	Extremes.				Mean.			
			Highest.	Lowest.	Max. Range.		Maximum.	Minimum.	Range.	Monthly Mean.
					Day.	Month.				
Interior Plains Class.	Aztec.	492	125.0°	65.0°	51.0°	60.0°	117.9°	74.50	43.4°	96.2°
	Ft. Mohave.	604	124.0	65.0	52.0	59.0	117.7	73.3	38.4	92.5
	Mohawk.	538	126.0	85.0	[7]		[7]	[7]		100.3
	Parker.	345	127.0	61.0	59.0	66.0	111.9	69.5	42.4	90.7
	Sentinel.	685	122.0	82.0	[7]		[7]	[7]		94.5
	Gilabend.[8]	737	120.0	68.0	48.0	52.0	110.5	73.1	37.4	91.8
	Averages.[9]	567	124.0	64.8[10]	52.5	59.2	113.0	72.6	40.4	94.3
Mountain Class.	Kingman.	3326	109.0	53.0	47.0	56.0	99.1	65.8	33.3	82.4
	Congress.[8]	3688	109.0	67.0	25.0	42.0	98.1	77.5	20.6	87.8
	Averages.[9]	3507	109.0	60.0	36.0	49.0	98.6	71.7	27.0	85.1
Gulf Class.	Yuma.	141	116.0	66.0	41.0	50.0	104.4	74.0	30.4	89.2
	Tinajas Altas.	1400	117.4	73.6	28.0	43.8	102.2	80.0	22.5	91.1
	Averages.[9]	770	116.7	69.8	34.5	46.9	103.3	77.0	26.3	90.6

GENERAL INFERENCES.

Through earlier observations in Arizona, Sonora and California the coastwise zone commonly called the fog-belt—an irregular zone extending inland from three to twenty-five miles (according to local configuration) from the Pacific and Gulf coasts—was well known, and its dominant influence on flora and fauna was understood; and the recognition of this zone led naturally to inferences concerning the more striking climatic features of Tinajas Altas and Yuma. So the records were soon seen to indicate the existence of a zone parallel with and inland from the fog belt which may be both denoted and described as a vapor belt, *i. e.*, a zone in which the aggregate volume of aqueous vapor is con-

typical stations of the southern division being introduced partly to illustrate the extension eastward of the two interior

[7] Not given in Jesunofsky's tables.

[8] Introduced from adjacent 'division' for comparison.

[9] Computed from Jesunofsky's figures (excepting Tinajas Altas).

[10] Excluding Mohawk and Sentinel records, in which actual minima do not appear.

[11] Published at Phœnix, August 22, 1905. Other monthly reports are entirely consistent, though not accessible at this writing.

siderable, although by reason of the prevailing high temperature it remains far above dew-point and so persists in notably stable condition. The volume of vapor is, of course, due to the proximity of the Pacific and the Gulf whence it is derived; its stability is due to the much higher temperature of the land surfaces over which it is carried by the prevailing air-drift, and the consequent warming of the air and rise of the dew-point. Of course the zone is atmospheric rather than terrestrial, meteorologic rather than geographic, and variable in position and character, with many factors of both configuration and climate; in some measure it grades into the fog-belt in both space and time; yet the observations, incomplete as they are, indicate that the vapor zone paralleling the Pacific coast is a definite physical entity.

On considering the relations of the vapor zone to the Californian Gulf, it was at once seen that the general climate and configuration of the region must tend greatly to increase its extent and enlarge its efficiency as a factor affecting what may be called the continental climate of the interior. During the summer the prevailing wind-drift over the region is eastward and northeastward, *i. e.,* from the open Pacific over the prominent backbone of the peninsula of Lower California and thence over the generally warmer waters of the enormously long trough forming the Californian Gulf, so that the volume of vapor would naturally exceed that drifting inland over an unbroken shore-line; then, once within the great sub-aerial trough, this vapor may not easily escape backward against, or in any other direction than with, the prevailing air-currents; it may not even flow down the trough to its open mouth 500 to 1,000 miles away, by reason of the great distance and the internal friction of vapor and air; hence it must form a vast reservoir of vapor overflowing (occasionally or steadily as conditions may determine) northeastward. The effective capacity of this reservoir must be greatly increased by the prevailing character of the land surface, of which from 50 per cent. to far more than 90 per cent. is bare white sand or rock from which heat passes rapidly and constantly by reflection and radiation and convection into the atmosphere, so that the air is highly heated and the vapor firmly fixed within it; it must be increased also by the augmented diathermancy of the atmosphere and the resulting intensity of insolation on the land surface attending the relative drying of the atmospheric mass with its rise in temperature; the effective capacity must be still further increased by the barrier forming the western rim of the trough (the sierras making up the backbone of the Californian peninsula) which tends to retard and check the westward-moving atmospheric wave marking the semi-diurnal increase in pressure consequent on morning insolation. These factors culminate in summer when insolation is strongest; and they would seem adequate to account for the persistent daily summer pressures in the gulf-trough which have already attracted the attention of climatologists.[12] In short, the preliminary survey of the climatology of southwestern Arizona indicates that just as the Californian Gulf is one of the world's greatest tide producers (its spring tides increasing from little more than two

[12] The barograph was carried from Yuma to Tinajas Altas at the courteous instance of Observer Hackett and with the approval of Chief Moore in the hope of obtaining better light on the character and distribution of these summer pressures, and it is probable that when the records are discussed they will be found to corroborate the inferences from temperature and moisture observations; although on looking backward over the summer's work it is easy to see that the barograph records would be much more valuable had another instrument been kept at Yuma for comparison.

feet at its mouth to twenty-five feet at its head), so its aerial portion forms an effective mechanism for promoting the flow and retarding the ebb of the atmospheric tide; and it may be noted that just as the oceanic tides produce astoundingly turbulent currents in the gulf waters mid-length of its trough, so the air-vapor tide results in the astonishingly sudden wind storms and strong williwaws of Tiburon Island and the adjacent coasts.

The extent of this vapor reservoir must be large, though variable from season to season (greatest in summer, least in winter), and from day to day according to a variety of factors and conditions which—like those of climatology in general—are commonly cumulative in effect. The coastward boundary of the vapor zone must shift with the conditions governing the presence or absence of fog, etc.; while the inland boundary must be determined from place to place by altitude, local configuration, presence or absence of floral covering, and other factors influencing temperature, dew-point, precipitation and storm centers. Tinajas Altas and Yuma would seem to lie in the vapor belt or reservoir, while Mohawk, Parker and other stations in the western division of Arizona would seem to lie without it. Proceeding from these points, with the guidance of the July and August storms in the ranges east of Sierra Gila, the summer inland margin of the vapor belt or reservoir may be drawn southeastward from Rio Colorado at a point twenty-five miles above Yuma to Rio Gila ten miles east of Gila City, and thence to and along Sierra de la Cabeza Prieta, crossing the international boundary near the eastern line of Yuma County; and thence more nearly southward and roughly parallel with the gulf coast to Hermosillo (Sonora) and on—gradually approaching the gulf—to regions beyond the influence of this great geographic trough: though it may be noted that the general vapor belt (apparently so greatly expanded about the Californian Gulf) must parallel much of the Pacific coast wherever configuration favors, perhaps attaining next best development in western Peru, where broad Piedmont plains of distinctively desert climate intervene between the Andes and the coast. Within the expansion of the Californian trough the vapor belt would seem especially potent in its influence on continental climate, through the development of storm centers if not otherwise—indeed, a considerable proportion of the effective storm centers traced in their course across the country during recent years, through the observations of the Weather Bureau, originate in this region.

Incidentally, the observations at Tinajas Altas throw light on a question suggested by earlier notes on the climate of Arizona and Sonora, *i. e.*, the question as to relation between what may be called the California type of climate, characterized by a winter rainy season and a summer dry season, and the Sonora type, comprising a winter rainy season and a summer rainy season, with intervening dry seasons; for in the light of the Tinajas Altas records it would appear that the types correspond, except that in the Sonoran region the effect of the vapor reservoir above the gulf in summer (when the land surfaces are hottest) is to develop storms drifting into the interior from the zone in which the vapor is for a time imprisoned.

A CONSTRUCTIVE SUGGESTION.

If the foregoing inferences are valid, it is manifest that the conditions existing about the Californian Gulf exercise important influence on the climate of the continent, and are worthy of correspondingly careful consideration. Any investigation might properly begin with observations made at a few suitably located stations,

which, fortunately, may now be found; these should include either one or both of the new towns west of Yuma, Calexico and Mexicala, together with Caborca, the westernmost town in Altar District, Sonora (to which the Mexican government telegraph line has recently been extended), and Hermosillo, the capital of Sonora. Doubtless cooperative stations might be established at these points; at the latter two perhaps in accordance with the law authorizing observations at points outside of the United States on Gulf of Mexico and Caribbean Sea. It would be well, too, to establish a record station on Rio Colorado between Yuma and Parker, and if practicable also at Quitobaquito (or Humboldt post-office) on the international boundary, some ninety miles east of Tinajas Altas. Records at these points would serve both to determine the limits and define the nature and influence of the vapor zone above the Californian Gulf.

W J McGee.

A SYMPOSIUM ON CHEMISTRY REQUIREMENTS.[1]

That charming and discerning essayist of to-day, Samuel M. Crothers, in a recent issue of *The Atlantic Monthly,* calls our attention to the delightful ease with which one may cultivate a good crop of fallacies by employing a heavy mulch of statistics. "The best way," he suggests, "is to prepare circulars containing half a dozen irrelevant questions, which you send to several thousand persons—the more the better. If you enclose stamps, those who are good-natured and conscientious will send you such odd bits of opinion as they have no other use for, and are willing to contribute to the cause of science. When the contributions are received, assort them, putting those that strike you as more or less alike in long straight rows. Another way, which is more fanciful, is that of arranging them in curves. This is called 'tabulating the results.' When the results have been thoroughly tabulated, use them in the manner I have described for the protection of your favorite arguments."

And yet it is less Crothers that speaks than his Scholasticus, a rather prosy, old-fashioned gentleman whose evident aversion for the times in which he lives and for the manners of those times forbids our taking him too seriously.

The symposium method may, I think, like any other method under the sun in the wide field of thought-husbandry, be made to stimulate and protect the growth of sound arguments as well as of fallacies. Of what kind it has brought forth on this occasion I must leave it to my patient hearers to determine.

It is both trite and untrue to assert that the south is backward in methods, but rather in lack of money to execute and realize methods. By careful inspection of the curricula of a list of southern institutions, even the smaller fresh-water colleges, we shall find that mention is nearly always made of the laboratory and of the library. Besides, a majority of these colleges are manned by competent instructors—young men educated after the most approved orthodox modern methods in American and European universities. This is especially true in the departments of the natural sciences, and particularly in chemistry. The crux of the situation is the poverty of all of our colleges, including state institutions, private foundations, and church colleges alike.

Of the three requisites for a good college, competent teachers, eager students and adequate equipment, naming them in the order of their importance—I take it that

[1] Paper read at the meeting of the American Chemical Society at New Orleans, December 30, 1905.