THE COLORADO DESERT.

By Charles Russell Orcutt.

No, the Colorado Desert is not in Colorado. It is in California. This great basin, near the mouth of the Colorado River of the West, forms one of the most extensive and important portions of the arid regions of the United States. The vast area known as the Colorado Desert, comprises all the country lying between the Colorado River on the east and the Peninsula Range of mountains on the west—a vast triangular-depressed plain, below the level of the sea for the larger portion of its surface, and comparatively destitute of verdure or of animal life.

This remarkable region has an approximate area of twelve million acres, about one half of which lies within the boundaries of San Diego County, California, the remainder in the Mexican territory of Baja California. This Colorado River Valley, as it is sometimes called, extends from the base of the San Bernardino Mountain, on the north, to the head of the Gulf of California, on the south. Its extent on the south, along the western shores of the Gulf of California, is practically unknown. On the north and northeast it is separated from the more elevated plains of the Mojave Desert by a low range of rugged hills, which extend from the San Bernardino Mountain to the mouth of the Gila River, and beyond into Sonora.

A similar desert borders the eastern bank of the Colorado River. This, known as the Gila Desert, extends up the Gila River for a considerable distance to the base of a range of mountains in Sonora. Little is known concerning the relationship of these nearly contiguous deserts. To gain an acquaintance with the one which we are now considering, it is desirable that we should know something about the other, and of the adjoining arid regions of Arizona and of Sonora.

The Gulf of California undoubtedly once occupied this entire desert basin not longer ago than the Pliocene epoch, and is still slowly and reluctantly retiring before the encroachment of the land that is forming from the debris of the Colorado River.

On the north, the continuation or eastern extension of the San Bernardino Range forms an inhospitable barrier between the great basin and the elevated plains of the Mojave Desert. This barrier is a low range of hills almost wholly destitute of vegetation, except in the arroyos, but remarkably rich in mineral wealth. From their rich chocolate-brown color, this range is frequently indicated on maps as the Chocolate Mountains; but the range is probably better known to miners and prospectors as the Chuckawalla or Lizard Mountains. This latter name is peculiarly appropriate from the great abundance and variety of lizards found in this region.

The Peninsula Range of mountains, with a varying altitude of four thousand to eleven thousand feet, rise in precipitous abruptness from the western borders of the desert plains. The crest of this mountain range

forms a sharp and well-defined line of demarkation between the arid region and the rich and fertile western slope of our county.

The summit of this Peninsula Range is usually clothed with forests of oak and pine. The western slopes are thickly overgrown with a varied vegetation, the valleys supplied with timber and water in a greater or less degree. Not so on the eastern or desert declivity of the mountains. The precipitous walls of rock, hundreds and often thousands of feet in height, present small inducements for vegetable life, and the less precipitous slopes are but slightly less devoid of botanical forms.

It is in the mighty chasms or cañons, eroded by the still active, tremendous forces of Nature, that the botanist has to look for his richest harvest. Some of these cañons, with walls three thousand feet or more high, contain scenery that for beauty and grandeur would rival even the Yosemite. Groves of the queenly Washington palms, growing with tropical luxuriance beside quiet brooklets, rival in beauty and novelty the giant sequoia groves of our State.

During June and July, 1888, the writer made his first exploration of that portion of the Colorado Desert that lies in San Diego County, traversing the northern arm of the great basin from San Felipe Valley, by Borrego and Fish or Indian Springs to Salton; and thence into the Chuckawalla Mountains, where the Pacific Mining District has been organized. The main object of this trip was the examination of various gold, silver, and lead mines which had been discovered in the district, for a gentleman who was largely interested in their development.

This district is still practically unknown except to a few interested parties. As it has, I believe, never been visited by any member of the staff of the California State Mining Bureau, I will give a brief account, for which I am largely indebted to memory. My field notes are, unfortunately, not by me, hence I am obliged to omit many details that might be of interest.

THE PACIFIC MINING DISTRICT.

This mining district is in San Diego County, and lies about thirty miles north of the Southern Pacific Railway. The nearest railway station is Salton, six hundred and thirty-seven miles from San Francisco. As organized, the district is some twelve by thirty miles in extent, but the mineral-bearing region is not thus limited. Perhaps no other county in the entire State of California possesses as large bodies of auriferous and argentiferous ores of as high an average grade as are to be found within the boundaries of this mining district. A broad arroyo furnishes a most excellent natural road from the railroad to the mines, and the grade is quite easy and uniform. The Cuyamaca Railroad survey through this pass is less than five miles away from the leading mining claims.

Good ironwood, mesquite, and palo verde wood can be cut and hauled to the mines at an average cost of $4 per cord. An abundance of good pure water has been developed in several of the arroyos around the mines, showing conclusively that no difficulty will be incurred in mining from the lack of water. The water has been developed by blasting in the rocks that form the bedrock of the arroyos, but as yet no water has been developed in any of the mines. This augurs well for the inexpensive working of the mines in the future.

None of the mines have as yet been developed beyond the stage of prospects, the owners not having sufficient capital for working them to advantage. Only one mill has yet been brought into the district, and that has proved totally inadequate for the work, being but little better than a "coffee mill," as it has been nicknamed.

I examined all the leading mines in the district at the time of my visit in 1888. I will mention the following claims on which the greatest amount of work had been done with the most encouraging results:

THE SUNNYSIDE MINE.—Ore from this mine has yielded by assay as high as $25,000 per ton, and is said to average about $50 to the ton in gold and silver. A shaft has been sunk to a depth of twenty feet, showing an increase in the width of the well-defined vein. The ore is very promising in character—iron-stained quartz, with an admixture of argentiferous lead ores. The mine is the property of Messrs. Hendsch & Frederick, of San Diego.

THE OPULENT MINE.—This is an extension of the last, owned by Messrs. Milton Santee, of San Diego, and W. F. Hendsch. From this mine I secured the first specimens of wulfenite recorded from San Diego County. A little galena occurs in this mine.

THE GOLDEN RULE MINE.—This is an old mine, worked years ago with good results, and then abandoned. It has been relocated and renamed, and a shaft sunk to a depth of fifty feet. Malachite and chrysocolla occur in this mine.

THE RED CLOUD MINE.—So named from the abundance of cuprite. A thirty-foot shaft has been sunk, and a tunnel commenced on the property.

THE ALICE MINE.—The property of the owners of the Opulent; yields a very attractive ore, containing an abundance of chrysocolla—with us considered a fair indication of silver. It is said to yield both gold and silver in paying quantities.

THE CHAMPION MINE.—This was a blind lead which gives promise of proving worthy of its name. It yields gold, silver, and lead in paying quantities, the lowest assay made yielding $17 65 to the ton. From that the ore runs up to $420 per ton in gold and silver. Argentiferous lead ores, wulfenite more especially, are characteristic of the ore from the Champion.

THE GREAT WESTERN MINE.—A ledge fifty or more feet in width that has been traced for miles; yields an average of $20 per ton in gold, with a trace of silver. The Keystone, Blackbird, and Monarch Mines are similarly large veins.

The very name of the Colorado Desert is sufficient to discourage many from engaging in mining operations within its limits. I believe, however, that when this portion of our State becomes better known it will lose many of its present terrors, and the present difficulties in the way of development will no longer exist. The scarcity of wood and water, and the intense heat which prevails in this region at certain seasons, are undoubtedly the principal objections which capital would consider as in the way of profitable investments in mining operations on the desert.

The first two of these objections are not valid; the intense heat is real. According to Dr. P. C. Remondino, however, even the intense heat does not interfere with labor in the mines on the desert, and my own experience confirms this view.

Dr. Remondino states, in the "West American Scientist" for August, 1890, that "sunstroke, heat diseases or accident, and hydrophobia, are here unknown (at San Diego), and the highest temperature of the foothills, or even of the desert—the latter reaching the enormous or excessive heat of 140 degrees Fahrenheit—is remarkably well borne, as workmen in the New Liverpool Salt Works, in the sink of the Colorado Desert, three hundred feet below sea level, in this county, labor in its summer heat with less annoyance or discomfort than that experienced by ordinary harvest hands in the fields of the Mississippi Valley. Here the heat, for some reason, has neither the enervating or the morbific effect of the same element in the East, as a degree of temperature that in New York would be prostrating and followed by accident, and a great mortality among the young and the aged, will on this coast hardly cause a feeling of discomfort."

My collection of mineral and rock specimens was secured at a time when the thermometer registered as high as 140 degrees Fahrenheit in the Pacific Mining District. There were several hundred pounds in weight which I had to pack over the trails—often two miles or so in length—on my back; yet I was not in any way inconvenienced by the heat, the warm, dry breezes being rather invigorating and healthy.

Considering the extent and richness of the ore deposits on this range of mountains, there seems to be no valid reason for their not being fully developed.

THE POOR MAN'S MINING DISTRICT.

This district lies southeast of the Pacific Mining District in the same range of hills.

Another mining district has been organized in the region of the Colorado River, to the northeast of the Poor Man's District, but I have no data concerning it at this writing available. It is said to contain valuable gold mines and extensive deposits of copper ore, at present scarcely available from the inaccessibility of the region where they are located.

MINERALS OF THE COLORADO DESERT.

Many of the mineral substances which have been collected by the writer on his various explorations in the desert have not yet been identified, but the following list of species reported from that region has been compiled. Mr. Hank's list of California minerals in the sixth report of the California State Mineralogist has been freely drawn from, as will be seen by the references given.

ACTINOLITE.—Abundant evidently in the hills near Salton, around Dos Palmas Springs.

AGATE.—A so called water agate is abundant at Cañon Springs. True agates are occasionally found on the surface of the desert in the drift. With the agates are often found beautiful chalcedonies and other stones of almost gem quality.

ALABASTER.—Gypsum is very abundant in portions of the desert, and some of it is nearly or quite of the quality of alabaster.

ALUM.—"At the mud volcanoes, San Diego County, and at numerous locations, as an incrustation on rocks."—*Hanks.* Held in solution by the water in the Dos Palmas and other springs, and deposited as an incrustation on the soil around them.

AMAZON STONE.—This beautiful mineral I believe has never yet been recorded from the Pacific Coast, but a specimen from the mountains of Baja California was recently examined. Whether from the eastern or western side of the mountains, I could not ascertain.

ARAGONITE.—A peculiar form, doubtfully referred to this species, occurs in radiating and nodular masses in many sections of the desert basin; is also found in narrow veins in sandstone formation, like satin spar is found.

ARSENIC.—This is a common mineral on the desert, judging by common report. Several springs are reputed to owe their poisonous qualities to the quantity of this mineral which their waters hold in solution.

ASBESTOS.—A large body of this mineral is being worked by the John D. Hoff Asbestos Company on the east slope of the San Jacinto Mountain. A fine lustrous-white, fibrous material, identified as a variety of asbestos, was found in the clay hills near the Mexican boundary by Mr. D. C. Mendenhall, to whom I am indebted for my specimens. It evidently does not occur in any great quantity in this locality.

AZURITE.—"Lost Mine, thirty miles west of the Colorado River."—Pacific Mining District, 1888.

BIOTITE.—Not rare in the granitic formations bordering the desert on the west.

CALCAREOUS SPAR.—Not rare.

CALCAREOUS TUFA.—Quantities of tufa rock, thrown up, or formed by mineral or thermal springs, occur in different sections of the basin. These springs are now for the most part inactive. Extensive deposits of this character exist south of Coyote Wells.

CALCITE.—Occurs abundantly in a multitude of varieties. (See cement rock, Iceland spar, etc.)

CEMENT ROCK.—This variety of calcite occurs in considerable quantity in San Diego County, and in no portion of the county is it more widely distributed than on the western borders of the great basin. Much of this is no doubt too impure to ever be of commercial importance, even if the question of transportation were satisfactorily solved. Some of the more accessible deposits, however, would seem worthy of test.

CHALCEDONY.—Pebbles of chalcedony are not rare; scattered freely over the surface of the mesa-like formations that border the depressed plains of the basin.

CHALCOPYRITE.—"San Diego County."—*Hanks.* I have not seen specimens of this from this county, but the copper mines near the Colorado River are said to furnish an ore composed mainly of copper pyrites.

CHRYSOCOLLA.—"Lost Mine, thirty miles west of the Colorado River." Abundant through the Pacific Mining District in several of the silver mines; also, found east of Julian, on the desert slope of the mountains. A rich ore, said to average $20,000 per ton in gold, but occurring in no large body, has recently been discovered in Baja California by some Mexicans. This mine is near the United States boundary, and known as the Tianama. The ore is principally composed of chrysocolla. Its presence in Southern California is usually considered as a good indication of silver, and in the Pacific District, as at Tianama, is associated with gold.

CINNABAR.—This is said to be found on the east slope of the San Jacinto Mountains, but thus far I have failed to secure specimens that would stand the test. I have several times seen specimens of this min-

eral from the mountains of Baja California, but whether from the desert region or from the western slope, the finders never could inform me, as they had paid no attention to it at the time of discovery, not knowing the mineral or its value.

CUPRITE.—"Lost Mine, thirty miles west of the Colorado River." Found sparingly in the Pacific District.

DOG-TOOTH SPAR.—Carrizo Mountain.

EPIDOTE.—Occurs near Ballena on the western slope of the mountains, a locality in this county worthy of record. Very fine radiating masses of this mineral were found in 1889, near the Alamo Mines, in Baja California; also, near the seacoast at San Ysidro.

FELDSPAR.—Numerous varieties occur near Mountain Springs, on Carrizo Mountain, and in other localities; some varieties of very fine quality.

FLINT.—Pieces occasionally found in the drift on the mesa-like plains of the desert.

GALENA.—Not rare in some of the mines in the Pacific District.

GARNET.—None of gem quality have yet been found on the desert, but millions of small size and inferior quality are found in the granite rocks and washes on the western borders of the basin. They were invariably found in washings for placer gold in this region.

GOLD.—Gold is found in quartz in many places on the eastern slope of the Peninsula Range of mountains, throughout the Chuckawalla Mountains, and in the low ranges of hills or mountains that diversify the surface of the broad plains of the great basin.

Several quartz mines have been located in the Jacumbe Valley during the past year, the owners of which are greatly encouraged with present prospects. Gold has been found in small quantity on the Carrizo Mountain, but no developments have yet been attempted.

Scarcely a quartz ledge in the Chuckawalla Mountains that will not yield a color to the industrious prospector, and many of these undeveloped mines will doubtless prove bonanzas to their owners in time. The reader is referred to the remarks upon the Pacific and Poor Man's Districts for mention of the leading mines that have thus far been even partially developed.

Wherever the prospector has used his pan on the mesa-like formations bordering the depressed basin, he has been rewarded with at least a color of placer gold. In every wash or ravine through the Chuckawalla Mountains, I am informed, gold has been found whenever sought with intelligence. In the bottom of Coyote Wells traces of gold have been found, and everywhere on the surrounding benches, but has as yet not been found in any place in sufficient abundance to warrant extensive operations.

In the Cocopa Range of mountains, south of the United States boundary, the Mexicans have found steady employment for some months past in apparently extensive placers. They claim to have been only moderately repaid for their labor, but as the miners at work in that locality are nearly or quite all outlaws of the Mexican Government, they presumably cannot do better than stay with these diggings.

The lack of an abundance of water for such operations, and other difficulties in the way of placer mining, will doubtless retard its development, for the present at least, in this inhospitable region.

GYPSUM.—Selenite, satin spar, and massive gypsum are abundant in

many parts of the desert, from near the Southern Pacific Railroad to the banks of Carrizo Creek, and southward into Baja California; generally distributed, in one form or another, throughout the region of the clay hills bordering the desert on the west.

HALITE.—Common salt. "Large beds of salt have recently been discovered in the alkaline lake or sink in the Colorado Desert, which are now worked successfully by an incorporated company under the name of the New Liverpool Salt Company." Salton is the station where these salt mines are being worked. Other extensive deposits of salt exist on Carrizo Creek, in Horse Thief Cañon, and at other points on the desert, but none so accessible and capable of immediate development as those of the New Liverpool Salt Works.

ICELAND SPAR.—Some beautiful specimens, in large masses, are found on Carrizo Mountain, and small fragments, often beautifully sculptured by the drifting sands, are scattered abundantly over the surface of the western border of the desert.

MAGNETITE.—"Eight or nine miles north of Mesquite Station."—*Hanks.* Pacific Mining District. Widely distributed in Southern and Lower California, and not rare in the desert region.

MALACHITE.—"With azurite, cuprite, and chrysocolla. Lost Mine, thirty miles west of the Colorado River." Pacific Mining District.

MARBLE.—See building stones.

MICA.—The black, the white, and a golden variety of mica are found in the granitic rocks bordering the desert on the west; nowhere in any great quantity, but widely distributed.

MOLYBDENITE.—"Campo."—*Hanks.* Abundant in this locality and farther east around the Jacumbe Valley, in the granitic rocks. At Jacumbe Valley it is associated with silver ore, or is itself argentiferous, the ore being said to yield "some $20 to the ton."

OBSIDIAN.—Fragments only—probably scattered by Indians—are frequently found on the surface of the plains, or in the cañons.

OPAL.—Specimens of an inferior quality are found in the Pacific Mining District. I have only seen a few, and have none in my collection.

PETROLEUM.—Some prospecting for oil has been done by several parties. Nothing has yet resulted, but some good indications are reported by a gentleman who has had long experience in eastern oil fields. The formation in certain sections seems very promising, and the writer hopes to thoroughly investigate the subject.

QUARTZ.—"Big Tank, Colorado Desert; silicified wood, chalcedony."—*Hanks.* Some fine quartz crystals come from the Pacific Mining District. The usual large variety of forms of quartz occur in this region. Silicified wood occurs in great quantity.

RUBELLITE.—Among a small collection of minerals recently shown me by a prospector, Mr. Jay Dedrick, I was pleased to find a specimen from the mountains of Baja California, where he had collected extensively, of rose-colored tourmalines. Mr. George F. Kunz, to whom I at once sent the specimen, writes: "The occurrence is identical with that of the material from Rumford, Maine. The tourmaline with the lepidolite is very pretty." The locality is south of the Alamo Mines, but I do not know whether it is within the limits of the Colorado Desert or not. In any case, the discovery is worthy of record.

SATIN SPAR.—See gypsum.

SELENITE.—"Dos Palmas Station, Southern Pacific Railway." (See gypsum.)

SULPHUR.—"At the mud volcanoes, described in the Second Annual Report of the California State Mineralogist." In the Cocopa Mountains a very great deposit of sulphur has been discovered. These Cocopa Mines are about sixty miles south of the United State boundary.

TALC.—Coyote Wells; associated with other minerals.

THINOLITE.—"Colorado Desert."

TOURMALINE.—Schorl is one of the most widely distributed minerals in the world, and occurs in many localities in San Diego County, usually in feldspathic veins, on either side of the Peninsula Range.

WULFENITE.—Abundant in the Champion and Opulent Mines, Pacific Mining District.

BUILDING STONES AND MATERIALS.

The Peninsula Range of mountains, bounding the Colorado Desert on the west, possesses a rich variety of the choicest of granite, marble, and sandstone, unsurpassed in quality for building purposes. Some of these varieties are exceedingly beautiful, but are still practically unavailable from their comparative inaccessibility.

The surface of the desert is strewn with fragments of marble for a large portion of its area. These are worn and beautifully polished or sculptured by the drifting sand, until each is in itself a natural ornament. Da Costa, in his "Natural History of Fossils" (1757), page 197, says that "yellow marble was more esteemed by the Romans than all other varieties." Some of the delicately tinted pink, yellow, and variegated marble specimens from this region would lead us to indorse the taste of these ancient connoisseurs.

Aside from the marble and limestone so abundant in this section, we find immense quarries of red and brown sandstones worthy of entering into the construction of the finest of palatial homes.

The following are the principal species of rocks found on the desert which may become useful in building construction:

Marble and limestone, in different grades.

Cement rock.

Pumice.—Abundant in the great basin.

Gypsum.

Asbestos.

Porphyry, lava, and other volcanic rocks.

Sandstone; red, brown, and gray.

Gneiss, granite, and other granitic rocks.

Dunnite.—"From Cargo Muchacho Mining District, San Diego County. This consists of three distinct minerals—olivine, magnetite, and a micaceous mineral, unknown." (See Sixth Annual Report of the State Mineralogist, Pt. I, pages 32–3.)

Breccia.—Suitable for building purposes.

Clay.—A variety of clays, suitable for a great number of uses, exist in large deposits of as great a degree of purity as could be desired. But little attention has naturally been given to these natural resources of our county. That these deposits will prove a source of wealth in the future cannot be doubted.

GEOLOGY OF THE COLORADO DESERT.

"Geology is the science which investigates the successive changes that have taken place in the organic and inorganic kingdoms of Nature; it inquires into the causes of these changes, and the influence which they have exerted in modifying the surface and external structure of our planet."—*Lyell.*

It is scarcely less than presumption to attempt to write a treatise on the geology of a region as vast as the Colorado Desert, after so short an acquaintance as the writer has yet enjoyed. A territory nearly as large as the combined areas of New Hampshire, Vermont, and Massachuetts cannot be exhaustively treated in a dozen pages, however, though our present knowledge can nearly be contained in that space. It may be well to briefly state the opportunities that I have had up to date for the study of this interesting region before entering upon a statement of the results of my observations.

Several hundred pounds of mineral and rock specimens, together with several thousand fossils, were among the spoils of my first exploration in 1888 to the Pacific Mining District. Another result was the desire to become better acquainted with this whole remarkable region.

In the spring of 1889, I invaded the confines of the Colorado Desert contiguous to the Mexican boundary, which yielded rich botanical returns for the time expended. Much valuable material illustrative of the fauna was also secured, together with a small series of rocks and fossils. The intense heat, combined with an insufficient outfit, cut short my observations at this time, after a month spent in the rugged cañons and on the sandy plains around Coyote Wells. In November of the same year I made small collections on the northern portion of the desert, from San Gorgonio Pass to the section west of Indio.

The first day of January, 1890, found me in the saddle en route to the desert again. Owing to unexpected delays, rains, and snow in the mountains, the party which I accompanied did not reach Coyote Wells—our first desert camp—until near the middle of the month. At that time the weather was very cold and disagreeable. Ice was found nearly every morning in our camp for a month, and though there had been abundant rains on the desert, vegetation was very backward. In consequence, I returned early in February, in a botanical sense, comparatively empty handed.

The six weeks spent at this time were not wholly wasted, however, since, in exploring the more promising cañons and plains around Coyote and Indian Wells, for a radius of twenty or thirty miles, in the vain search for plants, I became more deeply interested in the geology of the region, and secured, for lack of plants, a series of the minerals, rocks, and fossils. This section of the desert proved remarkably prolific in fossil forms of both plant and animal life.

During April, May, and June, 1890, I secured small series of specimens from this same region, supplementary to my earlier collections. In May I passed over the old stage route from the desert through Carrizo Creek—a route rendered famous by the Mexican boundary and Pacific Railroad surveys.

It is from these brief experiences of the pleasures of the desert, and the material which has thus accumulated in my hands, that I must rely on in the preparation of this paper. With the accumulation of more full

material and data, and the acquisition of a wider acquaintance with the subject, I must be permitted to change my present views, though the facts here recorded can never change.

THE QUATERNARY PERIOD.

The geological problems which confront us in the study of the great basin demand that we shall know something about the adjoining regions —Arizona, Sonora, the Gulf of California, and Baja California, as well as of the territory north and west in our own State. While the mineralogist may be satisfied with the various inorganic substances before him, and a knowledge of their chemical constituents, the geologist must pay still closer attention to the often indistinct organic remains in the rocks for suggestions as to their past history. To even approximately interpret the geological horizon from the testimony of the rocks, requires a knowledge of the characteristic features of the fauna and flora of the present day, as well as of the geological periods of the past.

"The region of country drained by the Colorado and its tributaries is about eight hundred miles in length, and varies from three hundred to five hundred miles in width, containing about three hundred thousand square miles."—*Powell.*

It is with the molluscan fauna of this large drainage area that we now have to do, in considering the Quaternary fossils everywhere distributed over the surface of the desert basin.

Dr. Robert E. C. Stearns read a paper some years ago before the California Academy of Sciences, entitled, "Remarks on Fossil Shells from the Colorado Desert," which was published in the "American Naturalist," XIII, 141–154 (March, 1879). His remarks were based on a lump of clayey sediment from near the bottom of a well sunk by the Southern Pacific Company at Walter's Station from a depth of about forty feet. This lump contained specimens of several species of fresh-water shells, *Physa humerosa*, *Tryonia clathrata*, and *Amnicola protea*. The surface of the desert where this well was sunk is one hundred and ninety-five and fifty-four hundredths feet below sea level.

At Salton, a station a few miles farther east, on the Southern Pacific Railway, these, and other fresh-water and marine shells as well, are found in countless myriads on the surface of the plain, which evidently once formed the bottom of an extensive lake or series of lagoons. This portion of the desert is generally designated as the Dry Lake. Salton is two hundred and fifty feet below sea level, and a part of this Dry Lake is depressed over three hundred feet. Along the shores of this lake these fresh-water shells are drifted into windrows in places where they may be scraped up by the quart.

In addition to the *Physa humerosa*, *Tryonia clathrata*, and *Amnicola protea* that were found in the well, *Amnicola loginqua*, *Anodonta Californiensis*, *Planorbis ammon*, and several marine species of shells were detected among this shell debris.

The desert is strewn in like manner, or in a less degree, with these same fresh-water shells as far south at least as the United States and Mexican boundary, along the course of New River especially. The whole of this area is probably below sea level.

Along the eastern base of the San Jacinto Mountains, an old beach-line is well defined, and can be easily traced for miles and miles from the line

of the railroad, always at the same level. The rocks are worn and rounded up to this old beach-line, sharp and jagged above. This line by actual measurement has been found to be even with the present level of the sea, while the greater portion of the basin is below this level. This would seem to indicate that this region was once occupied by the sea, or formed an arm of the Gulf of California, which once unquestionably extended fully two hundred miles farther inland than it does to-day.

Dr. Stearns, in the paper already cited, remarks:

> Shall we indulge in a guess as to the depth of the water when these shells were alive? Shall we add the depth of the well to the elevation of bench marks, the ancient levels which form terrace lines in some places along the distant hills, once a part of the shores of an ancient lake, the walls of the basin which once inclosed and held a fresh-water sea?
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> It may have been, however, that the lake was never so deep as the figures thus added would indicate, and that instead of a lake or a series of lakes, there existed only a lagoon or chain of lagoons, connected or disconnected, according to the volume of water, which probably varied one season as compared with another; a system of shallow reservoirs, receiving the catchment or surplus water in periods or seasons of unusual rainfall, sometimes, after a prolonged and widespread storm of great severity, uniting and forming an extensive expanse a few feet only in depth, as was seen in the valleys of California during the notable winter of 1861-62.
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> The rate of depression may have been such as to continue to keep the lagoons supplied, * * * and that only within a very recent period has this depressed portion of the Colorado Basin become bare and dry. Are the phenomena which this vast and remarkable region exhibits * * * the result of catastrophic action, sudden, violent, and widespread, or the result of gradual changes moving slowly through countless centuries?

The Indians, according to Dr. Stephen Bowers, still preserve the memory of catching fish along the base of the San Jacinto Mountains, where the Cahuilla Indians pointed out to him the artificial pools, or "stone fish traps," where their ancestors easily secured the fish on the receding of the tides of the ancient sea. Dr. Bowers has not yet published his researches among these Cahuilla Indians, so far as I am aware. This would seem to indicate that the change from an arm of the gulf is comparatively recent, and a study of the fossils from this region seems to confirm this view.

Therefore, the great basin cannot have been occupied by a fresh-water lake for any great length of time. The cause of the separation of this region from the gulf can readily be understood in the present encroachment of the land that is forming from the sediment and debris of the Colorado River, which empties into the gulf. With the formation of a barrier separating the basin from the gulf, the imprisoned waters were at once subjected to rapid evaporation. For years, perhaps, neither fresh nor salt water was added to the waters of the basin. But the presence of a brackish water mollusk would lead me to infer that the change from salt to fresh water was gradual.

With the rapid evaporation of that region, however, few years were requisite after its isolation from the sea before the salt of the sea water was precipitated into the vast salt mines now worked or capable of production, and until this region became virtually what it is to-day—a barren desert.

The main branch of the Colorado River doubtless hurried past as it does to-day to the gulf, only the annual overflow, surcharged with the fine reddish sediment, reaching the Colorado Basin. This was, however, sufficient to deposit the material for forming the great depth of the finest and richest of alluvial soil which exists along the route of New River to the Dry Lake.

The isolated sea thus was changed by evaporation and periodical inflows of fresh water into a series of alternately brackish and fresh-

water lagoons, somewhat as Dr. Stearns has suggested. As the sea changed to brackish water lagoons, the marine fauna gradually disappeared until the last few survivors, like *Solecurtus*, ultimately perished, mingling their exo-skeletons with the empty homes of the fresh-water shells which were annually brought down by the Colorado, gathered from widely separated portions of the territory it drained.

With the annual freshening of the water, the fresh-water shells thus transported for life by the Colorado gradually were able to survive from one season to another, until the conditions finally proved especially adapted for them. The following instances of the rapid multiplying of river and pond snails, in this connection, and as illustrating some problems of geographical distribution, will be of interest:

SOME OBSERVATIONS ON FRESH-WATER SNAILS.

At Sauzal, a ranch situated on Todos Santos Bay, Baja California (about one hundred miles south of San Diego by wagon road), an American erected a windmill some years ago to facilitate the irrigation of his fruit trees and garden. He banked up the earth around a little square in his garden where the surplus water was allowed to flow. An artificial pond was thus created, which probably was seldom, if ever, allowed to be dry, as it was utilized for watering stock and as a duck pond. I first became acquainted with this place in the spring of 1882. In April, 1885, I was surprised to find the muddy bottom and sides of this little pond lined with thousands of tiny living pond snails, about which the following note was printed in the "West American Scientist," I, 74 (October, 1885):

Limnæa humilis was collected by the hundreds in April, 1885, in a small artificial pond in the vicinity of Todos Santos Bay, Lower California. The pond was near ten years old, a few inches deep, and about six feet across, fed by a windmill from a well twenty feet deep. For miles there is no surface water naturally, and it was a great surprise to find this mollusk in such a location. How came it there?

How such numbers of this snail came to exist in this locality will always remain a mystery. The species, though rarely detected in Southern California, is of very wide distribution in Europe and America. Transplanted through some natural agency—possibly through the eggs adhering to the legs or feathers of the ducks—the species found the environment favorable to rapid increase. It is certainly an interesting fact to note in connection with the study of geographical distribution.

In countries where the ponds and streams are perennial in character, it is comparatively easy to account for the presence of the various members of the molluscan fauna. Many of our Californian streams are periodical in their flow, and few of the lagoons of Southern California are known invariably to withstand the extreme droughts to which they are subjected.

In April or May of the present year (1890), I was surprised to observe a multitude of fresh-water snails in a little creek near San Diego—usually dry, and never running except for a few months during the winter season. These snails were *Physa distinguenda* and *Limnæa adelinæ*, two species, I believe, peculiar to Southern California.

At this writing these snails are dead, and thousands of their empty homes are bleaching among the dry stones, or entombed beneath a thick mat of fresh-water algæ which choked up the stagnant pools as the water-

course gradually became dry. The shells in many individuals grew to an unusual size. It now becomes an interesting question whether these species will both reappear another season in equal abundance. That they had not previously been observed in this creek during the rainy season is not proof that they had not previously existed in this locality, but it seems more reasonable that the eggs of these snails had been introduced by a flock of water fowl in its annual migration as it stopped a moment to play in the young stream. This, however, scarcely accounts for the great number of individuals found.

The *Physadæ* have not been supposed capable of surviving long periods of drought, but possibly our West American species—like many species of plants—have adapted themselves to their environment in this respect, where half the year our rivers are said to be "bottom side up." Whether they are really capable of æstivation or not must be left for future observations and experiments to determine. It hardly seems possible that the eggs of these snails can withstand the baking in the sun to which they are subjected, and maintain their vitality. Nor does it seem probable that these mollusks could undergo the desiccating process which Nature here brings to bear upon her subjects during the summer months.

However, these statements conclusively show the rapidity with which these mollusks multiply, and accounts for the presence of such large numbers of shells on the Colorado Desert. Even if the system of shallow lagoons became annually dry, the snails would reappear in annually increasing numbers as long as they found the environment suitable.

FRESH-WATER SHELLS OF THE COLORADO DESERT.

ANODONTA CALIFORNIENSIS Lea, Trans. Am. Phil. Soc., 2d ser., X, 1852.—Types collected in the Rio Colorado, California, probably near Yuma, by Dr. J. L. Le Conte; collected in Utah Lake, by Dr. Edward Palmer, and in Bear River, by Henry Hemphill—both localities in the Wahsatch Range, Utah, at an elevation of over four thousand five hundred feet; also, in the Washoe Lake, Sierra Nevada, at an altitude of four thousand feet, by Mr. C. D. Voy; also, found in Owens River at the same elevation (four thousand feet) and near Los Angeles at an elevation of only two hundred and eighty feet, and elsewhere in California. Credited to the Mojave River and to Riverside, California. Santa Cruz River, near Tucson, Arizona, is another locality for this widely distributed species. Dr. Cooper includes *Anodonta Californiensis, A. Oregonensis, A. Wahlamatensis* (all of Lea) as varieties of *A. Nuttalliana* Lea, which is doubtless correct, crediting it to the Quaternary of the lake basins east of the Sierra Nevada. Dr. Stearns first reduced the above species of *Anodonta* to their proper varietal rank.

AMNICOLA LONGINQUA Gould, Proc. Boston Soc. Nat. Hist., V, 130 (March, 1855).—"Shell elongate ovate, horn-colored, surface quite smooth; apex obtuse; whorls five, well rounded; sutures deep, aperture elliptical, broadly-rounded posteriorly; lip simple, copiously incrusting the pillar margin, which is profoundly arcuate; umbilical region nearly perforate. Length, one eighth; breadth, one tenth of an inch.

"Found in the Colorado Desert (Cienega Grande) by W. P. Blake. It has a bleached or chalky color, probably from exposure, like the other species found on the Cienega Grande, a region which is immersed

a portion of the time and dry the remainder, and was once, apparently, an extensive marsh or shallow lake."—*Gould.*

Less abundant than *Amnicola protea*, but by no means rare on the desert. This species has been found living in Utah by H. Hemphill. Dr. Cooper credits it to the Quaternary of Lahontin Basin, Lassen County, and of Nevada.

AMNICOLA PROTEA Gould, l. c., V, 129.—Gould's name is said to have had actual priority of publication over Conrad's *Melania exigua*, which is treated by Binney and others as a synonym. Binney refers the species to *Tryonia*. These fresh-water forms need a careful revision. This is credited to Utah in a living state, and I have found what was referred to this species in the Dos Palmas Springs, near Salton. What is referred to this is by far the most numerous of all the fossil shells found on the desert, and, though one of the smallest species, its numbers are so great as to exceed the others in bulk as well.

TRYONIA CLATHRATA Stimpson.—Shell elongated, narrow; apex of spire acute; sutures deeply impressed; whorls eight, with generally about twelve longitudinal ribs crossing them, sometimes crossed by revolving striæ or ridges, and angulated in the middle; aperture rounded oval, very small; diameter, 1.5; altitude, 5 millimeters. Dry Lake, Colorado Desert. Specimens bearing this name in my collection and in the State Museum from the Colorado Desert, are identical with *Amnicola protea*. Specimens from Utah, received through the kindness of Dr. R. E. C. Stearns, show this to be a very distinct species, however, though I have as yet failed to identify it from the Colorado Desert—the original locality whence came the types.

TYRONIA EXIGUA Conrad.—Southern Utah, living. "Quat., Colorado Desert."—*Cooper.* This is *Amnicola protea*, according to most conchologists. Conrad's *Melania exigua.*

TRYONIA PROTEA Gould.—See *Amnicola protea.*

GNATHODON MENDICUS Gould.—"Colorado estuary to Mazatlan, Mexico, living. Quat., Colorado Desert."—*Cooper.* Originally found by Dr. Le Conte north of Carrizo Creek. I have a specimen, probably this, from near Salton.

SPHAERIUM.——?—Binney, in "North American Land and Fresh-Water Shells," Part II, page 71, mentions a Cyclas from the Colorado Desert, collected with the other fresh-water shells by Wm. P. Blake.

MELANIA EXIGUA Conrad, Proc. Phila. Acad. Nat. Sci., VII, 269 (February 1855).—The following is a copy of Conrad's original description: "Turreted; volutions eight, disposed to be angulated and somewhat scalariform above; cancellated, longitudinal lines wanting on the lower half of the body whorl; columella reflected; aperture elliptical. Length, one fifth of an inch. Colorado Desert, California.—*Dr. Le Conte.* The specimens are numerous and of a chalky whiteness, showing that they are all dead shells."

This has been treated hitherto as a synonym of *Amnicola protea* of Gould, but it may be necessary to reinstate the species, as several forms exist under the latter name.

PHYSA HUMEROSA Gould, l. c., V, 128 (February, 1855).—Types from the Colorado Desert fossil. Found living in the Colorado River, in Pyramid Lake, Nevada, in the "Pecos River," and evidently the same form in the Dos Palmas Springs, Colorado Desert. Reported from the Quaternary near Carson, Nevada. It is virtually only a form of *Physa*

heterostropha. It is very abundant on the Colorado Desert in a "semi-silicified" condition.

HELISOMA AMMON Gould.—See *Planorbis ammon*.

PLANORBIS GRACILENTUS Gould.—See *Planorbis ammon*.

PLANORBIS AMMON Gould, l. c., V, 129 (March, 1855); Otia, 216; Pac. R. R. Rep., V, 331, plate XI, Fig. 12; Pres. Rep. 23, 1855; Binney, L. and F. W., "Shells of N. A.," part II, page 112, Fig. 187.

Gould's original description is as follows: "Shell large, discoid, subconic, delicately striate; left side broadly and deeply concave, showing four obtusely carinated whorls; right side concave, showing two and a half rounded whorls; aperture ovate-triangular, sometimes quite expanded on each side; axis, five eighths to one; diameter, one fourth to one half inch. Found by Dr. T. H. Webb, in the Cienega Grande, or Colorado Desert, and also by Mr. W. P. Blake."

"Found living in Klamath Lake, Oregon, to Clear Lake, Lake County, Honey Lake, Lassen County, and Colorado River, California, and in Nevada. Found 'semi-fossil in Lahontin Basin.'"—*Cooper*.

This is about equally abundant on the Colorado Desert in a fossil state with *Physa humerosa*.

FURTHER OBSERVATIONS ON THE QUATERNARY PERIOD.

That we may more fully understand the changes which have taken place in late years, it is necessary to present a few facts which are now matters of history.

Twenty years ago the Colorado River was in the habit of annually overflowing its banks during the time of summer freshets, when the snows melted in the mountains whence the river has its source. This annual overflow (which is said to have been omitted from the programme of the Colorado River's actions as often as otherwise) formed a channel through the deep alluvial bottom lands of the great basin, to which the name of New River was applied by the earlier pioneers who crossed the desert on the old overland route.

Along the course of New River the Cocopa and other desert Indians planted and raised magnificent crops on the overflowed lands. Corn, melons, squashes, and other vegetables, and grain reached the rankest growth attainable, and some of these early pioneers who crossed the desert in those days, yet speak with wonder of the wonderful fertility of the soils, and of the success of these Indians in their agricultural labors during that period of the desert's history.

With the increasing infrequency of these overflows—now rarely exhibited in the Colorado, the Indians were compelled to depart—the Cocopas to the region of the gulf, the Cahuillas to the mountains around the northern arm of the desert. The deserted Indian huts may still be found among the mesquites of New River, but their former occupants will never return.

New River naturally drained the whole of the Colorado Basin, and finally emptied its surplus water—as it does to-day at rare intervals—into the bed of Dry Lake, where it quickly disappears by evaporation or disappears in the deep porous soil.

The fine sedimentary character of the soil in the bed of this dry lake, intermixed with immense quantities of vegetable matter consumed by a species of "dry rot," forms a surface very treacherous in character, some-

thing like a "dry bog," across which man may not venture without danger of disappearing beneath the surface at any step.

We thus see that it is only within very recent years that this region has actually become a desert in reality. Having noted the capacity of the fresh-water shells for becoming widely distributed geographically, and their remarkable fecundity under favorable conditions, we need no longer wonder at the immense numbers of these shells that are now strewn over the surface or imbedded in its alluvial soils.

Just south of the United States boundary line a barren range of rugged hills extends southward towards the Gulf of California. This is the Cocopa Range of mountains, in which valuable mineral deposits are known to exist. The most northern of the range is distinguished by the name of the "Signal" Mountain, from the top of which the Cocopa Indian once lighted his signal fires.

To the west of Signal Mountain there lies the dry bed of an almost mythical lake—the Laguna Maquata, whose waters are invariably described on the Mexican maps as *muy salada* ("very salt"). Very little reliable information concerning this region is obtainable. In 1884 the lagoon is known to have been a very respectable body of water, from the overflow from the Colorado in that year, which was divided between the New River and the Laguna Maquata Districts.

Thousands of fish are said to have sported in its depths—many of the fish "exceeding two feet in length." In February, 1890, this extensive lagoon was as dry as the surrounding country, with only a small pool of brackish or salt water at its point of lowest depression, connected with other small pools to the southward by muddy, inapproachable sloughs. Along the banks of this defunct lake were numerous remains of the unfortunate fish—all that the hungry coyote had spared, which my friend, Dr. C. H. Eigenmann, has identified for me as having belonged to the mullet (*Mugil Mexicanus*).

Along the bottom of the lagoon were found numerous examples of fresh-water shells, the same species of *Physa* and *Planorbis*, and the *Anodonta*, as occur in the Dry Lake.

A salt spring is said to exist in the bottom of this lagoon, but this is contradicted by others. Others still claim that it is connected with the Gulf of California, but I saw no indications of such being the case. Apparently the history of the Colorado Basin known as Dry Lake, is being repeated in Laguna Maquata to-day, though on a somewhat smaller scale.

I am informed, on apparently reliable authority, that numerous fish remains exist in a portion of the Dry Lake that I have not yet visited. It will be interesting to learn whether they belong to the same species as the Lake Maquata remains. One of the problems which confront the geologist at this stage is the presence at Salton and other points of marine mollusks associated with the fresh-water shells, all of apparently the same age and in the same stage of preservation.

Solecurtus and *Anodonta*, *Cylichna* and *Amnicola*, seems like a strange association of genera. This brings us to the beginning of the Quaternary period, or the close of the Pliocene age. The two are so closely associated that it is hard to draw a line between them.

THE PLIOCENE AGE.

That the Gulf of California extended to the base of the San Jacinto and San Bernardino Mountains during this age is plainly proved by the fossil shells which we find. The following is a list of the species thus far known to the writer from this region belonging to the Pliocene:

OCINEBRA POULSONII Nuttall.—Dr. R. E. C. Stearns informs me that he has this species from Indio. Living at San Diego to-day, and probably belonging to the gulf fauna as well.

OLIVELLA BIPLICATA Sowerby.—In the museum of the California State Mining Bureau there is a tray of fossil shells labeled "Colorado Desert, San Diego County, California.—*Albert T. Lee.*" Among them was an *Olivella*, which I very doubtfully refer to this species. Considerably smaller than *O. biplicata*, I presume it to be, perhaps, a gulf species with which I am unacquainted.

CONUS CALIFORNICUS Hinds.—In the same tray as the last; State Museum.

NASSA PERPINGUIS Hinds.—In the same tray with the last; State Museum.

NASSA COOPERI Forbes.—State Museum, with the last.

MACRON ——?—State Museum, with the last.

LUCINA ——?—Near Carrizo Creek; "Resembles *L. Californica* closely." —*Orcutt*, 1890.

CYLICHNA ——?—"Associated with *Amnicolæ* and other fresh-water shells, from Salton."—*Orcutt*, 1888. Resembles *C. inculta* somewhat.

SOLECURTUS CALIFORNIANUS Conrad.—"Associated with fresh-water shells; Salton. Abundant."—*Orcutt*, 1888.

Probably this list will be greatly enlarged when the desert is more fully explored. Several other species of mollusks, and a few other marine invertebrates, are already in my cabinet, unidentified, which I have provisionally referred to the Pliocene.

For lack of material this period is rather hastily dismissed for an older epoch, or rather to consider an older series of fossils from this prolific region—a series originally described by Conrad as Miocene, by Gabb referred to the Pliocene, but evidently, according to my judgment, not more recent than the Miocene, and more likely to prove of Cretaceous age, as Conrad is credited with having suggested later in life.

THE CARRIZO CREEK OYSTER BEDS.

"Approaching Carrizo Creek, we saw, for the first time in many days, strata of unchanged sedimentary rock. These consist of shales and clays of a light brown or pinkish color, forming hills of considerable magnitude at the base of the mountains. From their soft and yielding texture they have been eroded into a great variety of fantastic and imitative forms. This series of beds have been greatly disturbed, in many places exhibiting lines of fracture and displacement. Where they are cut through in the bed of Carrizo Creek, they contain concretions and bands of dark brown ferruginous limestone, which include large numbers of fossils, ostreas and anomias. These have already been described by Mr. Conrad, and are considered of Miocene age. In the debris of these shale beds I found fragments of the great oyster (*Ostrea Titan*), characteristic of the Miocene beds of the Californian coast. A few miles

north of this point, similar strata, probably of the same age, were noticed by Dr. Le Conte, but there they contain gnathodon, an estuary shell, showing that the portion of the desert where they are now found was once covered by brackish water."—*J. S. Newberry.*

In the spring of the present year (1890), I made a large collection of these fossil oysters in the neighborhood of Carrizo Creek, mainly to the south. A series of these was sent to the United States Geological Survey.

The following is the information elicited in return. This was signed with a rubber stamp by the "Chief Clerk:"

The oyster shells, coral, and sea urchins forwarded to this office for identification and referred to in your letter, have been examined by one of our experts, who reports:

"I have examined some oyster shells from the Colorado Desert, referred to in the accompanying papers and, also, the notes accompanying them. The species are probably Miocene; they are in very bad condition, so that it is difficult to speak confidently of their relations.

"The small oyster is *Ostrea subfalcata* Conrad. The oysters appear to be in a very bad state, and not identifiable with confidence. They are not distantly related to forms now living in the Gulf of California.

"The coral is waterworn and a pseudomorph in silica so that it presents no structure, and we can only say it belongs to the Ostræa family.

"The sea-urchins cannot be determined from the sketches, and very likely not from the specimens, as that group in our Tertiary has been but little studied, and there are many fossil species very little known. There is no one here who has studied them sufficiently to identify the species except those of our Atlantic Coast, and even these are in a very confused state."

Evidently the coral sent from the Colorado Desert had received no attention, as the above note seems to apply to another form from the Cretaceous beds along the coast of Baja California. The coral from the Carrizo Creek region is quite different in character.

All the specimens sent were numbered, to avoid confusion, as material from several localities were sent together. These numbers were wholly ignored, however, and the reports received leave me but slightly wiser than before. Other collections, sent from the Tertiaries of the Lower California coast in 1877, have not even yet been reported upon by the Survey.

I should like to learn what species of oysters exist in the Gulf of California that are not "distantly related" to these Carrizo Creek forms. They seem to me more nearly related to Cretaceous forms than to any living species with which I am acquainted.

More recent formations, evidently Pliocene in age, are found in the vicinity of these ancient oyster beds, and an acquaintance with these may have led Mr. Gabb to refer them all to that period.

The following is a list of the Tertiary *Ostreidæ* of California, so far as at present known to the writer:

OSTREA LURIDA Carpenter, Moll. W. N. Am. (S. I. Misc. Coll., 252), page 305; Heilprin, Fossil Ostreidæ of N. Am., 316, pl. 72, fig. 2, 3.—Pacific Coast, living and in the Pliocene beds.

OSTREA CONCHAPHILA Carpenter, Post-Pliocene.—"San Diego and False Bay, probably *O. lurida*."—*Heilprin*, l. c., 315. This species I consider a form only of the last.

OSTREA ATWOODI Gabb, Palæontology of Calif., II, 33–34, pl. x, fig. 58, 58*a*, and pl. xi, fig 58*b*; Heilprin, l. c., 312, pl. 48, fig. 4, 5.—"Miocene or Pliocene."

OSTREA VEATCHII Gabb, l. c., II, 34–60; Heilprin, l. c., 316, pl. 72, fig. 1.—Gabb places this in the Post-Pliocene. My specimens from Carrizo Creek seem closely related to, if not identical with, Lamarck's *Ostrea*

bellovacina of the Eocene strata of Europe. This, or a nearly related form, has been described from the Eocene of Maryland as *O. compressirostra* Say.

OSTREA HEERMANNI Conrad, Proc. Phila. Acad. Sci. (1855), 267; Pac. R. R. Rept., V, 326.—Described from Carrizo Creek, and referred to the Miocene. Conrad is credited with saying later that this is "probably a Cretaceous species."—*Heilprin*, l. c., 314. Gabb (l. c., II, 107) refers it to the Pliocene.

OSTREA SUBFALCATA Conrad.—The oyster identified as this species by the United States Geological Survey greatly resembles the figures of *O. larva*, a Cretaceous species, credited with a wide distribution in Europe, India, New Jersey, and Alabama. Whether identical or not can only be determined by a careful comparison of a large series of authentic specimens.

OSTREA VESPERTINA Conrad, Jour. Phil. Acad. Nat. Sci. (n. s.), II, 300; Mex. Bound., I, 160; Pac. R. R. Rept., V, 325; Heilprin, l. c., 315; Gabb, l. c.—Conrad described this from Carrizo Creek, and referred it to the Miocene. Gabb considered it Pliocene, but was undoubtedly in error. Cooper credits it to the Pliocene of Santa Barbara, San Fernando, Los Angeles County, and to the Colorado Desert. It has also been credited to the vicinity of San Diego; but only the original locality where the types were collected (Carrizo Creek) can be considered authentic. Cooper in referring it to the Pliocene simply followed Gabb in compiling his list of California fossils. I should rather refer it to the Cretaceous than to a more recent period than the Miocene.

OSTREA TITAN Conrad, Pro. Phil. Acad. Nat. Sci., VI, 199; Jour. of same (n. s.), IV, 300; Pac. R. R. Rept., VI, 72; Heilprin, l. c., 313.—Characteristic of the Miocene of the California coast. Carrizo Creek. "Throughout Upper Miocene of the Coast Ranges to Lower California."—*Cooper.*

OSTREA TAYLORIANA Gabb, l. c., II, 34; Heilprin, l. c., 313.—Miocene.

OSTREA PANZANA Conrad, Pac. R. R. Rept., VII, 193; Heilprin, l. c., 313.—Miocene. "Perhaps mature *O. subjecta*."—*Conrad.*

OSTREA SUBJECTA Conrad, l. c., 193; Heilprin, l. c., 313.—Miocene.

OSTREA VELERIANA Conrad, Mex. Bound., I, pt. II, 160; Heilprin, l. c., 314.—Miocene (?) of Arizona. Colorado Desert (?).

OSTREA GALLUS Valenciednnes, Voyage de la Venus Atlas de Zoölogie, pl. 21.—A recent species figured without description, *O. cerrosensis* Gabb (l. c., 35, 106), from Cerros Island, is considered identical. Heilprin, l. c., 315. I have this from the Pliocene of San Quintin Bay, Baja California.

ANOMIA SUBCOSTATA Conrad.—Miocene. Carrizo Creek.

PECTEN DESERTI Conrad.—Miocene. Carrizo Creek.

BALANUS ——— ?—Miocene. Carrizo Creek.

Various gasteropods and an echinoderm are in my collection from this same region, together with a coral, a few fossil plants, etc. Until more material has been secured and carefully studied, it is thought best to postpone further remarks on these interesting remains.

In the shale near Coyote Wells, I secured the impressions of the leaves of evidently some species of aquatic plant with floating leaves, resembling in shape somewhat that of the genus *Brasenia*, as L. F. Ward suggests.

The Carboniferous period seems to be represented also among the fossils from this region. W. P. Blake has also reported fossils of this age

from the Colorado Desert, principally corals from the drift, which may belong to some very remote part of the drainage area of the Colorado River. (Pac. R. R. Rept.)

BIBLIOGRAPHY.

The next best thing to knowing everything is to know where to obtain information. The following list has therefore been compiled in the hope that it may supplement my own paper, and that my attention might be called by my co-laborers to work which I might have overlooked:

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Report of the United States and Mexican Boundary Survey. In three volumes.

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CONCLUSION.

In closing, I would acknowledge the courtesies extended to me by the Mexican Land and Colonization Company, of London, through their former manager, the late Major Buchanan Scott, which enabled me to explore portions of this region during the last spring, that I otherwise might not have been able to have examined so thoroughly. For photographs of the two desert views herewith presented, I am indebted to Messrs. Briggs, Ferguson & Co., of San Francisco.

The report of Mr. Wm. P. Blake (Pac. R. R. Rept., Vol. V, pp. 174 and 228) is herewith especially referred to as valuable complement to this article, and which is the most complete account of the surface geology of the desert region that has yet been published.

I have not thought best to lengthen this contribution to the geology of the desert, by attempting, even in a general manner, to cover the whole subject, and have preferred not to duplicate what has appeared from other writers on the subject.

It has been found necessary to make occasional quotations to fully illustrate such portions of the subject as I have treated, but full references have been given.

A more comprehensive treatment of the subject may be attempted in the near future, when the failings of this hastily prepared article may be corrected.

It is hoped that the collections of the University of California, and of the California Academy of Sciences, may soon be accessible for the comparison of the types of the old California Geological Survey with later collections. Without such comparison being made, the identification of many of our fossils must still remain in some doubt. Many types of Californian fossils, furthermore, are now in eastern and European museums, where they are equally as inaccessible as the collections which still remain on our coast.