statement could be accepted without much qualification, we might derive great comfort from the assurance that chemical examination of soils shows the presence, within reach of the plough, of nine thousand pounds of potash, and half as much phosphoric acid, on every acre, or enough to furnish the average crop for from two hundred and twenty-five to two hundred and fifty years.

Now, in the first place, the average land in tillage at the present time by no means reaches such a standard; and, in the second place, it is well known that but a very small fraction of the plant-food actually present in soil is in an available form. Ordinarily more than ninety-nine per cent of the plant-food found in soil by the chemist the plant itself finds dormant or unavailable. Time and natural agencies gradually convert their inert elements; but, to keep pace with agricultural demands, the physical properties of soils must be closely studied, and knowledge obtained and applied regarding the proper mechanical treatment of land. Figures already sufficiently demonstrate the recognized condition and needs of the soil. So difficult is it to make the once fertile land take back into use the natural resources, and so active the demand for plant-food in every available form to return to the soil, that, incredible as it appears, commercial fertilizers are maintained at such selling rates as to make the entire annual farm-products of this country worth half as much for manure as they are in market.

With our rapidly increasing population, and a constantly lessening fertility of soil, we have presented to us questions of the gravest import. By the wasteful processes prevailing, we are expending our very substance, and daily adding to a burden under which generations to come will stagger.

The true economy of soil management, involving the production for our people of food and clothing, fuel and shelter, and the wise management and disposition of our surplus, are problems great enough to satisfy the ambition of both scientists and statesmen.

In all expositions of the condition and prospects of the agriculture of this country, Gen. Francis A. Walker claims that the American people have been fully justified, upon sound economical principles, in the past system of cultivation of the soil at the expense of future generations.

"Thirty-eight noble States, in an indissoluble union, are the justification of this policy. Their school-houses and factories, their roads and bridges, their railways and warehouses, are the fruits of the characteristic agriculture of the past."

But the reason for wasteful systems no longer exists. "The country in the arable parts is settled, and the line of population now rests near the base of the great sterile mountains which occupy so large a portion of the continent. . . . A continuance of this policy will be, not the improvement of our patrimony, but the impoverishment of our posterity. . . . Economical and political considerations alike demand that the soil bequeathed to this generation, or opened up by its own exertions, shall hereafter be deemed and held as a sacred trust for the American people through all time to come, not to be diminished or impaired for the selfish enjoyment of its immediate possessors."

These considerations should increase our regard for and interest in the business of farming. We should all rejoice at the revival of agricultural studies, and the increasing number of able men who are making them their life's work.

Let me cordially invite continued contributions to the proceedings of this section, upon foods, fabrics, forestry, industrial education, and other topics closely related to our material welfare. And I appeal for more encouragement and aid for the earnest workers in other sections,— in biology and chemistry, physics and mechanics,— who are laboring in the various branches of science, that its practical results may be applied to economizing the fertility of the soil, which is the basis of our material prosperity.

MENTAL SCIENCE.

The Sense of Smell in Dogs.

DR. G. J. ROMANES, by his careful observations and happy generalizations, has made himself the representative of the growing science of comparative psychology. His two books on animal intelligence and on mental evolution in animals (to which is to be added a third on the mental evolution of man), written under the inspiration of Darwin, have done more, perhaps, than the works of any other writer, to introduce scientific order into a field formerly given over to poorly described, exaggerated stories, and hasty, unwarranted generalizations. With the downfall of the anthropomorphic theory of the universe, the importance of the mental phenomena observable in animals was more readily recognized and appreciated. Hundreds of observations drawn up with the requisite details and accuracy have been collected, and a number of reliable and suggestive generalizations have been recorded. To these Dr. Romanes has added an important study on the method by which his dog follows the scent of the master.

The observations were made on Dr. Romanes' setter-bitch, an animal very much attached to him. They were made on the grounds adjoining his house, and a number of precautions not easily described were taken. (1) When Dr. Romanes walks over the ground with his hunting-boots on, the dog follows the scent with the greatest readiness. (2) If she is put to the track of a stranger, she pays no attention to it. (3) The dog was led into the room when preparations were going on for an outing, but, instead of Dr. Romanes going out, the gamekeeper (whose scent he follows next after that of Dr. Romanes) went: when set free, the animal at first followed the track, but, finding that her master was not with the gamekeeper, returned. (4) The next experiment was a very ingenious one. Twelve men walked in Indian file, so that they all trod the same footsteps, thus producing a conglomerate of olfactory impressions. Dr. Romanes headed the company, so that the traces of his steps should be most obliterated; and, after walking thus two hundred yards, the first six men walked in one direction, the last six in another. The dog quickly ran along the route followed by the twelve, overshot the point of division, but soon returned and followed the direction taken by the six headed by Dr. Romanes. (5) A number of experiments were made to ascertain what part of Dr. Romanes' person or of his apparel gave the clew to the animal. It was suspected to be the hunting-boots, and this proved correct. A stranger put on these boots, and the dog eagerly followed the scent; and, contrariwise, when (6) Dr. Romanes put on the stranger's boots, the animal was indifferent to his track. (7) Further experiments were made to locate the source of the scent in the boots. The dog did not follow the scent of a stranger walking in bare feet. (8) When Dr. Romanes walked in bare feet, the dog followed the trace, but less eagerly than usual, and with much hesitation. (9) Again, the animal did not follow Dr. Romanes when he put on new shooting-boots. (10) Next a single sheet of brown paper was glued to the soles of his usual hunting-boots. The dog did not catch the trail until he came to a place where, as Dr. Romanes had previously noted, a few square millimetres of the paper had come off. (11) When her master walked in new cotton socks, the trail was lazily followed, and soon given up. With woollen socks worn all day the result was the same. (12) Dr. Romanes next walked fifty yards in shooting-boots; then three hundred yards in his stocking-soles, carrying his boots; then three hundred yards in his bare feet. The animal caught the scent, and followed it unhesitatingly through the whole distance, though the trace left by stockings or bare feet alone was not sufficient to guide the animal. (13) The next test was a modification of the last. Dr. Romanes and a stranger entered a carriage and drove for several hundred yards. The former, in his hunting-boots, then alighted and walked fifty yards, whereupon he re-entered the carriage, and the stranger walked the next two hundred yards: the dog, when shown the track, ran the whole two hundred and fifty yards without pausing. The experiment was repeated with another stranger, with the same result. (14) To test the power which the dog had of selecting the distinctive odor accompanying her master from other odors, Dr. Romanes soaked his hunting-boots in anise-seed-oil. The odor was so strong that a friend could follow the track an hour later by the odor of the oil; yet the dog was not confused except that she hesitated about the first few steps, but then pursued as usual.

The next test was directed towards ascertaining whether the animal could distinguish her master by odors emanating from other portions of his person. (15) Dr. Romanes, after pursuing a zigzag course just trodden over by a number of footsteps, hid behind a wall, with his eyes just visible. The animal went at once to the hiding-place. (16) Again he hid in a ditch, with only the top of his head visible. At two hundred yards the dog detected her master, and went to him directly.

From these tests, Dr. Romanes concludes that the dog distinguishes him from all others by the odor of his boots (1 – 6), and does not distinguish him in his naked feet (8 – 11). The odor is probably emitted by the feet, but must be mixed with that of shoe-leather to be of service to the dog. This is doubtless a matter of education: had the dog been used to following her master when without shoes, the animal would have learned to follow him thus. The characteristic odor cannot penetrate a sheet of brown paper, but a few square millimetres of surface is sufficient to give the dog the clew. The animal is ready to be guided by inference as well as by perception, but the inference is instantaneous (12 and 13 as compared with 2, 8, and 11). Lastly, not only the feet (through the boots) but the whole body emits an odor that the dog can distinguish in a mass of others (15). This order is recognized at great distances to windward (15), or in calm weather in any direction (16): it is not overpowered by anise-seed-oil (14) or by the footprints of another (4).

THE TIME NECESSARY TO PERCEIVE COLD AND HEAT.—It is well known that a cold sensation reaches consciousness more rapidly than a sensation of warmth. Dr. Goldscheider of Berlin, whose researches on the hot and cold points of the skin have gained him a well-deserved reputation, has recently accurately measured the length of the time necessary to perceive these sensations. The observations were made on parts equally sensitive to heat and cold, and with intensities of heat and cold equally different from the temperature of the part. The time of contact was recorded electrically by means of a metallic button fixed to the skin. Contact with a cold point was felt on the face after 13.5, on the arm after 18, on the abdomen after 22, on the knee after 25, hundredths of a second. The sensation of a hot point was felt on the same surfaces after 19, 27, 62, and 79 hundredths of a second respectively. This great difference in time has an important theoretical bearing on the physiology of dermal sensations.

BOOK-REVIEWS.

Geological History of Lake Lahontan, a Quaternary Lake of North-western Nevada. (U.S. Geol. Surv., Monogr. XI.) By I. C. RUSSELL. Washington, Government. 4°.

THIS volume, and the companion monograph by Gilbert on Lake Bonneville, are undoubtedly among the most interesting, if not the most important, contributions hitherto made to the ancient geography of this continent. It must be admitted, however, that the wonderful changes in the aspect of the Great Basin, of which we find here the most conclusive evidence, are scarcely ancient in the geological sense, having been accomplished almost wholly since the close of the glacial epoch, and largely since the advent of man.

Lake Lahontan, situated mostly within the area now forming the State of Nevada, filled a depression along the western border of the Great Basin, at the base of the Sierra Nevada; while Lake Bonneville, embraced almost entirely in the present Territory of Utah, occupied a corresponding position on the east side of the Great Basin, at the foot of the Wasatch Mountains.

The hydrographic basins of these two water-bodies embraced the entire width of the Great Basin in latitude 41°. Lake Bonneville was 19,750 square miles in area, and had a maximum depth of about 1,000 feet. Lake Lahontan covered 8,422 square miles of surface, and in the deepest part, the present site of Pyramid Lake, was 866 feet in depth. The ancient lake of Utah overflowed northward, and cut down its channel of discharge 370 feet. The ancient lake of Nevada did not overflow. Each of these lakes had two high-water stages, separated by a time of desiccation. In the Lahontan basin, as in the Bonneville, the first great rise was preceded by a long period of desiccation, and was followed by a second dry epoch, during which the valleys of Nevada were even more completely desert than at present. During the second flood-stage, the lake rose higher than at the time of the first high water, and then evaporated to complete desiccation; for the present lakes of the basin (Pyamid, Winnemucca, etc.) are of comparatively recent date, and are nearly fresh, for the reason that the salts deposited when the quaternary lake evaporated were buried or absorbed by the clays and marls that occupy the bottom of the basin.

As Lake Lahontan did not overflow, it became the receptacle for all the mineral matter supplied by tributary streams and springs, both in suspension and in solution. The former was deposited as lacustral sediments, and the latter as calcareous tufa, or formed desiccation products when the lake evaporated.

The introductory chapter contains a sketch of the Great Basin as the explorer finds it to-day. It stands in marked contrast in nearly all its scenic features with the remaining portions of the United States. The traveller in this region is no longer surrounded by the open, grassy parks and heavily timbered mountains of the Pacific slope, or by the rounded and flowing outlines of the forest-crowned Appalachians; and the scenery suggests nought of the boundless plains east of the Rocky Mountains or of the rich savannas of the Gulf States. He must compare it, rather, to the parched and desert areas of Arabia and the shores of the Dead Sea or the Caspian.

To the geographer the most striking characteristic of the country stretching eastward from the base of the Sierra Nevada to the Rocky Mountain system is that it is a region of interior drainage. For this reason it is known as the 'Great Basin.' No streams that rise within it carry their contributions to the ocean; and the climate is dry in the extreme, the average yearly precipitation not exceeding twelve or fifteen inches.

The area thus isolated from oceanic water-systems is 800 miles in length from north to south, and nearly 500 miles broad, and contains about 208,500 square miles. At the south the valleys of the Great Basin are low-lying, Death Valley and the Colorado Desert being depressed below the level of the sea; but at the north the valleys have a general elevation of from 4,000 to 5,000 feet, while the intervening mountain-ranges rise from 5,000 to 7,000 feet above them.

The mountains exhibit a type of structure not described before this region was explored, but now recognized by geologists as the 'Basin Range structure.' They are long, narrow ridges, usually bearing nearly north and south, steep upon one side, where the broken edges of the strata are exposed, but sloping on the other with a gentle angle conformable to the dip of the beds. They have been formed by the orographic tilting of blocks of the earth's crust, that are separated by profound faults, and they do not exhibit the anticlinal and synclinal structures commonly observed in mountains, but are monoclinal instead. The mountains are rugged and angular, usually unclothed by vegetation, and owe their marvellously rich colors to the rocks of which they are composed, especially the purple trachytes, the deep-colored rhyolites, and the many-hued volcanic tuffs so common in western Nevada, often rivalling the brilliant tints of the New England hills in autumn.

The valleys or plains separating the mountain-ranges, far from being fruitful, shady vales, with life-giving streams, are often absolute deserts, totally destitute of water, and treeless for many days' journey, the gray-green sagebrush alone giving character to the landscape. Many of them have playas in their lowest depressions (simple mud-plains left by the evaporation of former lakes) that are sometimes of vast extent. In the desert bordering Great Salt Lake on the west, and in the Black Rock Desert of northern Nevada, are tracts hundreds of square miles in area showing scarcely a trace of vegetation. In winter, portions of these areas are occupied by shallow lakes, but during the summer months they become so baked and hardened as scarcely to receive an impression from a horse's hoof, and so sun-cracked as to resemble tesselated pavements of cream-colored marble. Other portions of the valleys become incrusted to the depth of several inches with alkaline salts, which rise to the surface as an efflorescence, and give the appearance of drifting snow. The dry surface material of the deserts is sometimes blown about by the wind, saturating the air with alkaline particles, or is caught up by whirlwinds and carried to a great height, forming hollow columns of dust. These swaying and bending columns, often two or three thousand feet high, rising from the plains like pillars of smoke, form a characteristic feature of the deserts.

Chapter II., on the genesis of Lake Lahontan, contains a summary of the facts which show that the lake filled a compound