more money was subscribed than was required for the festival.

It is not strange that Haeckel's work should be thus appreciated, for he was not only one of the first to recognize the importance of Darwin's writings, but after Darwin's death he carried on the work that he had begun, making the University of Jena the center of this line of thought.

ARTIFICIAL FERTILIZERS.

LIEBIG said: "We cannot suppose that a plant can attain maturity even in the richest mould without the presence of matter containing nitrogen, since we know that nitrogen exists in every part of the plant. . . . We have not the slightest reason for believing that the nitrogen of the atmosphere takes part in the processes of assimilation of plants. But there are numerous facts showing that the formation of substances containing nitrogen in plants takes place in proportion to the quantity of ammonia, derived from animal matter, which is conveyed to their roots." Although plants are constantly bathed in air, which consists mainly of nitrogen, and although nitrogen is an essential constituent of plants, yet Liebig believed that all plants would starve unless supplied with nitrogen in the form of ammonia.

De Saussure kept plants in a glass globe containing pure air, free from ammonia. He said: "I continued the experiments a long time, but I never could detect a diminution of the air in the globe. Plants do not absorb nitrogen from the air, and these experiments are confirmed by those of Woodhouse and Sennebier. It is certain that plants derive nitrogen only from ammonia."

Boussingault concluded that leguminous plants, pease, beans, clover, etc., possess the power of appropriating, as food, nitrogen from the air, while cereals and all other cultivated plants do not possess this power.

Professor Hellriegel and his associates discovered that there is a relation between certain knotty protuberances, or root tubercles, which abound upon the roots of leguminous plants, and the acquisition of nitrogen from the air. It was found that leguminous plants whose roots are free from tubercles do not gain nitrogen; that leguminous plants which have root tubercles gain nitrogen, and that leguminous plants which are free from root tubercles gain tubercles and also nitrogen by inoculation with a needle from the punctured root of a plant of the same kind which possesses root tubercles, or by simply sprinkling soil, or infusion of soil, from plants having root tubercles upon the roots of the plants which possess no root tubercles. The inference from these facts is that the acquisition of nitrogen from the air by leguminous plants, which causes them to improve soil instead of exhausting it, is due to micro-organisms, bacteria, or fungoid growths, and it suggests the possibility that, under conditions yet to be learned, other plants may also feed upon the nitrogen of the air.

The hydrogen which is taken up by plants appears to be obtained by the decomposition of water, the oxygen being given off. The carbon, which is the principal element in plants, appears to be derived entirely from the small percentage of carbonic acid gas which is always present in the air. If it is possible also to derive the nitrogen, which is a necessary element in plants, from the air, then the matter of fertilizing soil will be limited to supplying the non-volatile or mineral elements required by plants.

It is said that a process has been recently discovered for utilizing the nitrogen of the air in the production of sulphate of ammonia. It is said the gases or vapors of coal or petroleum are heated to 2,200 deg., the carbon and hydrogen separate, air is introduced, the mixed gases are passed over lime, a cyanide is formed, which is decomposed by steam, and finally sulphate of ammonia is obtained, it is said, at a cost of a cent a pound. We quote this reported process simply for the purpose of showing that the chemistry of a not distant day may be able to extract a fertilizer from the air which will renovate our soils and increase production.

We know that nitrogen is necessary to the full development of our cultivated plants. We know that the atmosphere, four-fifths of which is nitrogen, is an inexhaustible and ever-present source of nitrogen. We know that most plants are unable to feed upon the free nitrogen of the air, and that but one class of plants is able to appropriate it. We know that leguminous plants, beans, pease, clover, etc., which gain nitrogen from the air, renovate and improve our soil instead of impoverishing it. We know that the nitrogen of the air can be combined with hydrogen from organic substances and from ammonia, "which is soluble in water and can be conveyed to the roots of plants, which forms soluble compounds with all acids, and is capable of undergoing a multitude of transformations." Sir Humphry Davy conveyed vapor of ammonia through a glass tube into the soil among the roots of grass. He said "a very distinct effect was produced upon the grass; it grew with more luxuriance than the grass in any other place."

Knowing these facts, it seems not incredible that water is a fertilizer, furnishing hydrogen to plants, and that the air is a fertilizer, furnishing carbonic acid and ammonia to plants. When we have learned how to utilize air and water to the best advantage as fertilizers, two blades of grass will grow instead of one. We have not yet learned how to utilize fully the commonest things.—Barbados Taxpayer.

DISA VEITCHII X.

IN this beautiful plant, obtained by intercrossing *D. grandiflora* and *D. racemosa*, Messrs. Jas. Veitch & Sons, Royal Exotic Nursery, King's Road, Chelsea, produced the first, and still one of the best, of the new race of garden hybrid *Disas*, which are destined to become general favorites, as they give a class of terrestrial orchids with most beautiful flowers, which do not require to be grown in an orchid house, as they thrive remarkably well in a shady corner of an ordinary greenhouse or conservatory, if they are carefully tended and kept always moist, rain-water being used for them in preference to water from any other source. The flowers, which last a long time in perfec-

DISA VEITCHII X.

tion, are rose-purple, with dark crimson and yellow markings in the center.—The Gardeners' Chronicle.

RUBUS JAPONICUS TRICOLOR.

THIS is one of Messrs. J. Veitch & Sons' introductions, and was shown by them at the meeting of the Royal Horticultural Society on July 10 last. As seen it was a slender-growing trailer, with stems and leaf petioles of rose color, the leaves showing much white in patches among the green of the rest of the leaf surface, the youngest leaves being pinkish white. It would make a pretty greenhouse climber, or basket plant; or, layered in small pots, a very suitable subject for table decoration.—The Gardeners' Chronicle.

RUBUS JAPONICUS TRICOLOR—VARIEGATION PINK, WHITE, AND GREEN.

[ASTRONOMY AND ASTRO-PHYSICS.]

THE SEAS OF MARS.*

By WILLIAM H. PICKERING.

THE first observation made upon Mars at the Lowell Observatory with the 18-inch Brashear lens was upon June 1, 1894. Since then observations have been continued upon nearly every night. What appears to me to be the most important conclusion deducible from our work so far is that Mars does not always present the same appearance at the corresponding time upon two successive Arian years. This remark does not apply merely to small details, but to large and prominent features. Moreover, this difference does not seem to be due simply to the fact that one season is a few weeks later than the other, but that the phenomena presented upon the two years are really different.

Thus the central branch of the Y, just north of Noachis, which was so marked a phenomenon in 1892, was not visible to me early in June, as I had expected it to be. It is true that Mr. Lowell thought he saw it faintly marked, but although I looked for it upon the same evening, I could not satisfy myself of its existence. Nevertheless, the definition was such that had it appeared as it did in 1892, it could not have been missed at the first glance. I looked for it again at the following presentation in July just passed, but no trace of it was to be seen. Two drawings made by Professor Campbell upon July 18 and 20, 1892, and published in the last number of the publications of the Astron. Soc. of the Pacific, p. 171, show it very nicely indeed. These may be compared with some reproductions of my own work now originally published in *Astronomy and Astro-Physics*, 1892, page 668, and now republished in the same number with the drawings of Professor Campbell. After the disappearance of the central branch in the latter part of July, 1892, a portion of it reappeared in August, and remained visible through September. A sketch showing its appearance upon September 4, 1892, has been kindly forwarded to me by Mr. Russell, of the Sydney Observatory, N. S. W. This branch may therefore be said to have been characteristic of the opposition of 1892. This same region was very carefully sketched by Mr. Douglas and myself a number of times between June 30 and July 6, 1894, but not a trace of the central branch could we detect. Upon these dates Mars held the same position in its orbit that it did upon August 12 and 18, 1892. A sketch made by myself August 13, 1892, shows the central branch very clearly. It will be interesting to hear if its appearance has been noted this year by the Australian observers, since in their longitude it would have been visible about the middle of June.

But not only has the central branch of the Y been invisible this year, but the large dark blue patch which it connected with the southern snow cap, and which we call the Northern Sea, has been very much less marked, and much smaller than was the case in 1892.

Again a large black gulf bounding the melting snow upon the north and situated very nearly due south of Syrtis Minor has been a striking feature of our obser-

* Communicated by the author.

vations this year. This gulf was only observed once in 1892, upon July 27, and it was then by no means conspicuous. If these very dark regions are, as we suppose them to be, water, it would then seem that the water which did not reach the northern regions this year has appeared as an excess in the south.

Upon testing this black region upon June 4, with an Arago polariscope made for me by Mr. Brashear, it was found to show clear traces of polarization, as did the canal running north from it. This would naturally be the case if it were water, since being situated near the limb, it would reflect to us largely the light of the Auran atmosphere. Upon the rest of the disk of the planet the polarization was not very conspicuous. At the next presentation of this region, upon July 9, the observation was repeated, but to my surprise no trace of the polarization in the dark spot could be detected. A close examination of the region was then made, and its color was found to have entirely changed, whereas upon June 9, Mr. Lowell writes: "Bay a deep blue, looks just as deep water does." It was now found to be of a rich chocolate brown tint, differing entirely in color from the bluish gray regions to the north of it. These gray regions showed no sign of polarization, and as I have before remarked, I see no reason for supposing that their color is due to water. As far as my observations go, it appears to me that the permanent water area upon Mars, if it exists at all, is extremely limited in its dimensions.

The large gray regions were of a brilliant and decided green color in 1890, just before the vernal equinox. In the early part of 1892 also, large green areas were seen upon the planet, but as the season advanced the green regions changed almost entirely to gray. At the present time very little color is visible in the shaded regions. They are subject also to such large variations in area, as the season progresses, that unless we can persuade ourselves that gigantic floods, unaccompanied by clouds, form the normal condition of affairs upon Mars, we seem forced to adopt some other explanation of their existence. The theory that they owe their color to vegetation is perhaps the most plausible one, and some new facts bearing upon this matter have recently come to hand. Upon June 30 a distinct depression in the terminator where it was crossed by the stem of the Y was detected by Mr. Douglass. As the planet rotated, the position of the depression changed, and it was noted that it was not always found in portions of the terminator which were darkest. Since that date similar depressions more or less marked have been detected upon nearly every evening. Upon looking over our observations for 1892, I find under date of September 20, 8 h. 6 m., a drawing showing a flattened terminator, and a statement that "the planet seems somewhat of this shape." Further investigation shows that the long narrow strip known as Ceraunius was lying upon the terminator at about this time. These notches in the terminator can be most readily explained by actual depressions in the surface of the planet, and as Professor Campbell has shown (Pub. Astro. Soc. Pac. 1894, p. 110) a difference of elevation of the surface amounting to two miles ought to be readily visible to us on the earth at certain seasons, provided the elevation or depression involved occurred upon the terminator. It thus appears that we are perhaps on the eve of being able to construct a contour map of the planet. The observations involved are, however, very difficult, and no great accuracy in the results can as yet be expected.

Strictly speaking, the notches in the terminator correspond to variations in the inclination of the surface of the planet, rather than to variations in its level; but if we could determine the inclination and know the distance through which it extended, we should have all the data required for our work.

There is one conclusion, however, to which these observations lead us at once. Since these notches in the terminator do not necessarily occur in the darkest parts of the gray regions, and since different portions of them are notched to different depths when on the terminator, it follows that all portions of the gray regions are not on the same level. In other words, hills and valleys occur in them, and, consequently, the gray regions do not represent the surface of an ocean.

Lowell Observatory, Flagstaff, Arizona, July 13, 1894.

AUSTRALIAN SHEEP AND WOOL.*

By HENRY G. KITTREDGE.

THE foreign wool exhibit at the World's Columbian Exposition had a twofold interest to Americans, because of its great intrinsic merit and of the part it is likely to play in the near future in the manufacturing industry of the country as representative of the wools that will enter our ports in large quantities free of duty. No finer exhibit of foreign wools was ever before seen in the United States. The Argentina wool exhibit was a revelation to our manufacturers for its great excellence, more because of their unfamiliarity with the wools which the exhibit represented than for any particular points of superiority which it possessed over that from Australia. In case of the importation of wool free of duty, the Argentina wools, both the merino and the cross breeds, will be more seriously considered for our manufactures than would have been the case had no exhibit of this kind been made.

It is my purpose, however, to confine my remarks to the wool exhibit of New South Wales, with an occasional allusion to that of Victoria, Australia. The colony of New South Wales is the mother colony of the Australian group. Her wool exhibit was under the immediate charge of Alexander Bruce, chief government inspector of stock in the colony, and for the past forty years identified with the pastoral industry of Australia. To him is due the credit of eradicating the scab disease from among the sheep flocks of New South Wales by strictly enforcing the law requiring thorough dipping of sheep at shearing time in prophylactic decoctions.

The New South Wales exhibit contained representative wools from all the sheep districts of the colony except those of Cobar, Ivanhoe, and eleven small districts whose flocks numbered, in 1891, 2,400,000 sheep. Thus less than 4 per cent. of the number of sheep in the colony were unrepresented at the Fair, and this small proportion was confined chiefly to the uninviting re-

gion between the Lachlan and Darling Rivers. There are 63 sheep districts in New South Wales, and 20 wool districts, containing altogether, according to the 1891 stock returns, about 62,000,000 sheep. By reference to the map, the various wool districts, or 19 of them, will be seen indicated upon it. It will be observed that the railway intersects most of them. The wool districts, according to their importance in the number of sheep, are as follows:

	Sheep.
Lachlan.....	5,452,571
Riverina.....	5,231,146
Upper Murrumbidgee.....	5,099,381
Upper Darling.....	4,808,672
Western Darling.....	4,745,382
Southern Riverina.....	4,101,115
Castlereagh.....	4,076,196
Liverpool Plains.....	4,055,365
Namoi.....	3,909,830
Western Riverina.....	3,267,946
Bathurst.....	2,979,550
Gwydir.....	2,856,598
New England.....	2,581,642
Bogan.....	1,709,055
Monaro.....	1,439,841
Mudgee.....	1,181,644
Hunter River.....	695,152
Goulburn.....	641,428
Lower Darling.....	631,176
Total.....	59,463,990

Over 37 per cent. of this number of sheep are in the districts between the Lachlan and Murray Rivers; over 24 per cent. in the northern districts, from Castlereagh River to the upper tributaries of the Darling River; and nearly 14 per cent. in the Upper and Western Darling districts.

There are about 13,200 sheep owners in New South Wales; 750 of these own over 62 per cent. of the whole number of sheep. The flocks owned by these large proprietors range in size from 20,000 to 500,000 and 600,000 sheep. Seventy-three of these own nearly one-sixth of all the sheep in the colony, distributed among the different wool districts as follows:

Seventeen in the Riverina and Lachlan districts, owning 2,528,704 sheep; 15 in the Upper Darling, Bogan, and Castlereagh districts, owning 2,548,384 sheep; 19 in the Gwydir, Liverpool Plains, and Namoi districts, owning 2,440,785 sheep; 18 in the Western and Lower Darling districts, owning 2,420,398 sheep; and 4 in the district about Cobar and Ivanhoe, owning 454,503 sheep. The great flocks are west of the western slope of the mountain range.

The various breeds of sheep in the colony are the Merino long-wooled sheep, as the Lincoln, Leicester, Downs, and Romney Marsh, and the cross breeds, principally the long-wooled breeds with the Merino. Over 97 per cent. of the sheep are Merinos. Over 70 per cent. of the Merino sheep yield combing wool, the remainder yielding clothing wool. Over 17 per cent. of the combing wool sheep produce a superfine grade of wool, and about 46 per cent. a medium grade. Of the long-wooled sheep the Lincoln is in the greatest favor, though the Leicester is in no mean repute. It is generally thought among the flock masters of Australia that there is no room for improvement in the quality of the Merino fleece by any further admixture of European or American blood. Some efforts have been made in the direction of building up the avoirdupois of the animal, but they have not proved generally successful, as deterioration in the quality of the wool has followed. Large carcasses for mutton, as experience has demonstrated the world over, are inconsistent with superiority in the fineness of wool.

The geographical position of Australia is a grand one, an ideal one for sheep husbandry, where the climate is neither too hot nor too cold, tempered by the breezes that come over the surrounding sea, and where the air is clear and dry. On the east coast there is a chain of mountains generally known as the Great Dividing Range, extending north and south some 1,500 miles, in many places coming within 30 miles of the ocean, and touching it at Point Danger, between Queensland and New South Wales. Its highest elevation is in the southern part of New South Wales, where Mount Kosciusko rises 7,120 ft. above the sea level, and where snow may be found at all times of the year. The colonies of New South Wales and Victoria occupy the choicest parts of the continent, where the climate is congenial, and where the best lands are to be found for pastoral and agricultural pursuits.

New South Wales is divided into three physical divisions, designated as the coast district, the mountain district, and the western district. The latter two we shall have most to do with in connection with my subject. The coast district is a narrow strip of land from 30 to 150 miles wide, watered by a number of small streams having their sources in the mountains. The home of the mutton breeds of sheep is distinctively to be found here. The mountain district embraces the high lands and elevated plains that extend the whole length of the colony and slope gradually toward the west. This district varies in width from 120 to 200 miles. With the extension of the railway system and the increase in population this district is becoming more agricultural and less pastoral. The soil is rich and highly productive; the herbage is excellent, and were it not for the higher wants of agriculture, the land would be taken up from choice for the pasturage of sheep instead of that further to the west. The western district includes all the area from the elevated plains to the Darling River and beyond. All this region is now given over to grazing purposes, and with a general system of irrigation, as is now in contemplation, it will become equal if not superior to the most beautiful parts of the colony for husbandry of all kinds. As it is, sheep thrive there in a remarkable degree, very largely on account of the dry and healthy character of the climate. All the great rivers of the colony are found in this district. From Bathurst, northward to the 25th degree of latitude, all the western streams are tributary to the Darling River. This river is navigable from Walgett to its junction with the Murray River, 1,758 miles, thence to the sea. At some periods of the year its waters are very low; but four, and oftentimes twelve months' navigation, can be depended on as far as Bourke. This allows the transportation of wool and other things at certain seasons. The Murray River

and its tributaries form the most important river system in the colony. The Murray has never been known to be dry, being fed by the heavy rains and snow on the mountains about Mount Kosciusko. This perennial flow in such steady volume cannot be said of any other stream in the colony west of the mountains. It is navigable from Albury to the sea, 1,703 miles. The Murrumbidgee River is navigable up to Gundagai, while the Lachlan is navigable for several hundred miles. The great triangular region in the western district, lying between the Lachlan, Bogan, and Darling Rivers, has no surface streams. It is a comparative desert, yet some of the flocks of sheep in Australia are pastured there, about Cobar and Ivanhoe. The wools of this section were the only ones of New South Wales not represented in the World's Fair exhibit. The country northwest of the Darling River, notwithstanding its undulating formation, has, also, no surface streams of consequence, and the few streams there have their beginning and ending in the sands, excepting at occasional flood times, when one or two of the principal ones empty their waters into the Darling. Were it not for this lack of surface water the western plains of New South Wales would be the finest pastoral country in the world. This objection, however, bids fair to be overcome at no very distant time by the sinking of deep wells, by means of which the underground waters can be brought to the surface in abundance. Experiments have been made in this direction sufficient to establish a reasonable amount of certainty that it is possible to obtain an unfailing supply of water from below the surface.

The region west of the Lachlan and Bogan districts is the salt bush country of New South Wales. It is not regarded with particular favor for the raising of fine-wooled sheep, on account of the heat and the vegetation peculiar to a light, sandy soil of saline characteristics. But this region is improving, as the country east of it has improved and is improving, for both pastoral and agricultural purposes. All of this broad expanse of country is for the Merino, not the mutton sheep. While the Merino sheep will not thrive in the coast region because of the climate being too moist, the mutton sheep will not thrive in the interior on account of the climate being too dry. But the mutton breeds are not good for a new country for reasons distinct from climate.

The climate of Australia has had a peculiar influence upon the fleece and fiber of Merino wool, improving it in almost all particulars. The wool has been made softer and more elastic. If there has been any deterioration, it is in the density of the fleece; but this has been made good in a large degree by increased length of staple, so that there has been little or no loss in the weight of the fleece. It is difficult to say in what locality climate has had the most beneficial effect upon the fleece of the Merino. Certain it is that no place has been found superior in this respect to the Mudgee district, where an experience of over sixty years has shown that no better wool has been grown than there. So far as experimental knowledge goes, this district may be considered as possessing all the essential elements for the superior growth of Merino wool. The mean annual temperature of Mudgee is about the same as that about Nice, in Southern France. It is very much like that of the great sheep walks of Spain. The mean maximum temperature in the hottest months is about 86°, and the mean minimum temperature in the coldest months is about 38°, taking the records of 1891 as a standard.

The rainfall for that year was 34 inches, but this was 27 per cent. above the average, the mean annual rainfall being nearer 26 inches. The mean annual rainfall in the Bathurst (24), Upper Murrumbidgee (23), and Liverpool Plains (25) districts is about the same—a few inches less. The mean annual rainfall through the Darling River valley is 12 inches at Wentworth, 13 inches at Wilcannia, 16 inches at Bourke, and 19 inches at Walgett. In the Bogan district the mean annual rainfall is 17 inches, while about Cobar and Ivanhoe it is only 12 inches, but through the Riverina districts it is from 26 to 28 inches.

Ever since 1820 there has been a constant improvement in the breeding and preparation of wool for the market. It was about this time that sheep breeding was commenced in the Mudgee district. In 1860 special attention was directed toward improving the fineness of the wool, owing to the increased demand for it at relatively high prices. This led to the importation of French, German, and American blooded Merinos, of the Rambouillet, Negretti, and Vermont types, respectively. The German and American Merinos were in special favor, chiefly for the density of their fleece. Improvement in the length of staple soon followed, because of the increased demand for it for combing purposes. A change in the style of breeding resulted in more attention being given to purely Australian bred sheep, which were found to possess special qualifications for the growth of long-stapled wool, not observed in those imported from Europe or America.

The French, German and American bloods, however, were conspicuous in the specimens of New South Wales wools at the World's Fair. The Vermont blood was found almost, if not wholly, pure in some of the specimens from the Gwydir, New England, and Riverina districts. It was prominent in crosses with Australian types of wool, known as the Wanganella, Collaroy, and Tasmanian. The German blood was found almost pure in specimens from the Hunter River and Mudgee districts. The Collaroy blood, being the name of a stud flock at Merriwa, is derived from a Rambouillet and Saxon cross, and appeared to be a favorite infusion in many of the specimens from the Upper Darling, Gwydir, Namoi, and Monaro districts, and pure in many of the specimens from the Bathurst, Bogan, Castlereagh, Gwydir, Hunter River, Liverpool Plains, and Mudgee districts. Some of the Collaroy fleeces weighed 18 to 19 pounds. The Collaroy-blooded wool is characterized for luster, evenness, and length of staple. The Collaroy and Brinley Park estates at Merriwa are famous for the high character of their Merino blooded flocks. The Brinley Park wool was represented by two specimens at the World's Fair. The sheep from which this wool was taken are descendants of a few rams and ewes imported into Australia, in 1830, from Silesia. Subsequent importations were made, one being made in 1860 of several rams from the renowned flocks of Prince Lichnowski. Great care has always been practiced in culling and

* A paper read before the Society of Arts, Boston, Mass., January, 1894. From the Technology Quarterly.