tudes may be considerably increased if desirable, or the present standard of accuracy may be maintained at much less cost than formerly.

The results of all triangulation in California south of the latitude of Monterey Bay are printed in the concluding appendix in full, including descriptions of stations as well as their latitudes and longitudes and the lengths and azimuths of the lines joining them. In compact and convenient form there is given all the information in regard to this triangulation that is needed by an engineer or surveyor who wishes to utilize the results in controlling and checking surveys or in constructing maps or charts. The locations of more than 1,300 points are accurately fixed by this triangulation.

The report, in addition to the details of the foregoing operations and results, contains a record of a wide range of important work for which the aid of the Survey was sought because of the special training of its officers. The Superintendent attended the Fourteenth General Conference of the International Geodetic Association as delegate for the United States, and maintained direction of the observatories at Gaithersburg, Maryland, and Ukiah, California, supported by the International Geodetic Association for the purpose of measuring the variations of latitude; he was also detailed for duty in connection with the presentation of the case of the United States before the Alaska Boundary Tribunal, being assisted by one of the officers of the Survey. As Commissioner of the United States he continued the work of remarking the boundary line between the United States and Canada from the Rocky Mountains westward, two of the officers of the Survey being employed in the field; and as Commissioner of the United States in the International Delimitation Commission he inaugurated the work of marking the boundary between Alaska and Canada, one of the parties being under the direction of an assistant of the Survey. One officer continued on duty as a member of the Mississippi River Commission. One officer having completed the field work of the survey of Mason and Dixon's line, the boundary between Maryland and Pennsylvania, was then detailed to prepare the maps and report showing the results of the work. Another officer, at the application of the municipal authorities, remained in charge of the triangulation of the Greater New York territory; and one representative of the Survey, in co-operation with the Louisiana Oyster Commission, continued the survey of the natural oyster beds and reefs for the State of Louisiana.

BLUEBERRY CULTURE.

In grazing sections throughout the West an old and well-known custom is that of burning the dry grass to improve the next year's pasture. Formerly the fires were allowed to spread and burn themselves out at will, and the practice resulted in great forest destruction. Happily for the forests, the burning is now more carefully done when it is done at all, and on the whole the custom is falling into disuse. In Maine a practice of burning exists which is local to that State, is novel in character, and has nothing to do with grazing. The burning is to assist blueberry culture by causing the bushes to sprout vigorously and clearing the ground of other growth.

About 1870 a factory for canning blueberries was located in Maine, and as it prospered it was followed by others. In 1885 and again in 1899 similar factories and canning companies were established, until to-day blueberry raising and canning is an important industry in that State. To supply the increasing demand blueberry bush areas have been constantly enlarged, until now "blueberry barrens" cover some 2,600 acres in Hancock and Washington counties.

A century ago these "blueberry barrens" were, for the most part, covered by a dense forest, chiefly of white pine and spruce. The forest was thinned by lumbering the pine, and the increased amount of light permitted new kinds of undergrowth to get a foothold. Fire, as almost invariably happens, followed the lumbering, the rest of the original stand was destroyed, and the undergrowth was still further altered, a great variety of valueless underbrush and weeds taking possession of the ground, together with a stand of birch, popple, red maple, and other hardwood seedlings. As the fires continued to occur this hardwood growth became scrubby and was finally entirely eliminated, and the ground became a true barren, covered with a growth of blueberry bushes, sweet fern, brake, bunchberry, goldenrod, and sheep laurel. With the ground in such condition its best use is for blueberry culture.

The blueberry owner divides his land into three portions; each year he picks the berries from one portion, burns another portion, and allows the third to rest. The first year after the land is burned over the blueberry bushes sprout and grow a few inches. The second year they yield a full crop of berries. The third season the crop is small and of little value, and the bushes reach a condition in which they can be burned most effectively.

Under this system of blueberry culture the land does not "run out" with constant use for the same crop. Where the burning has been properly done, the same tracts have grown blueberries continuously for fifty years without showing any decrease in the yield. But if the land is burned over at the wrong time of the year, or the roots of the bushes are badly injured by fire, many years are required to restore the productive capacity of the tract. The best time for burning is when the melting snow leaves the ground wet and the tops of the bushes dry. After May 10 burning is very injurious, unless the spring is exceptionally late.

The canning companies own most of the blueberry lands in Maine, except some small 25 or 50 acre private holdings. Pickers from company lands get 3 cents a quart, while private owners receive about 6 to 8 cents a quart for their berries. The picking season lasts six weeks. A rapid picker makes from \$4 to \$8 a day; if he has a large family to help him it is not unusual for him to make \$600 or \$800 in the six weeks.

GIRLS EXTRACTING THE FIBER.

This makes the industry very popular among the pickers, and increases the danger that forest fires will be set or permitted to burn through good timber in order to increase the extent of blueberry barrens.

In addition to the 2,600 acres of present barrens, there are in Hancock County over 5,000 acres which have been reduced almost to a barren condition. Here, if necessary, this industry could be profitably extended. But when lumbering and fires have not materially depleted the forests, the land should be continued under forest cover and the stand improved. The opportunity is ample for a proper extension of blueberry culture without invading valuable forest lands, which should be protected from fire. The wisest policy is to utilize the present blueberry barren areas to the fullest extent, and not to encroach further upon the forests, except as the growth of the industry makes it profitable to take old cut-over lands for this purpose.

MYSTERIOUS WHITE RACES.

By L. E. NEAME.

THE idea that in remote parts of the tropics, amid the dark-skinned races, there exist mysterious isolated white tribes bearing a strong resemblance to Europeans has long possessed a curious fascination for the Old World. The early adventurers in Central and Southern America brought home many tales of extraordinary cities beyond the mountains, and vague stories afloat in South Africa thirty or forty years ago furnished Mr.

and better educated than the darker masses whom they avoid. Who they are and whence they came no one knows; native fables afford no explanation. Once it was thought that forgotten white explorers might have built up unknown kingdoms in the wild places of the earth. But upon examination these theories vanish as rapidly as do the white tribes themselves, and the ultimate explanation is almost prosaic.

Yet so strong a hold has the idea gained that even at the beginning of the twentieth century the possibility of the existence of a genuine white race is not altogether scoffed at. It is less than two years ago that an American officer engaged in the operations against the Moros in the Philippines collected apparently substantial evidence relating to a mysterious white tribe in the island of Mindanao. The mountainous district in the center of this island has never been explored, and even the coast is not well known. But along the seaboard many stories are told of the fierce white people who have their home in the forest-clad mountains of the interior. Eye-witnesses depose to having seen a strange, fair-complexioned girl loitering near a coast village, but who fled toward the hills as soon as she was addressed. Other men and women of a light-complexioned race are said to have been seen by more venturesome natives who were bold enough to approach the wild mountain district. The United States officer was so impressed that he determined to conduct an exploring party across the center of the island. But apparently the mysterious white folk had vanished, for the world has as yet heard nothing of his search being crowned with success.

Arabia, however, can with more reason boast of a white tribe. For years stories of such a race have been told in the Persian Gulf, and the Rev. S. M. Zwemer, an American missionary stationed at Muscat, alluded some time ago to "coffee-house babble in eastern Oman concerning a mysterious race of light-complexioned people who live somewhere in the mountains, shun strangers, and speak a language of their own." Various theories have been propounded to explain the fable; but probably the explanation is to be found in the narrative of a journey made in Oman in 1876 by Col. S. B. Miles, published some time ago in the Geographical Journal. Col. Miles, in the course of his travels nearly thirty years ago, came across a town named Sheraizi in the heart of the Green Mountains. This strange place was perched like an eagle's nest on the top of a great cliff, and was inhabited by a people of lighter skin than the rest of the tribes of the interior. They rarely descended to the plains, and refused to mix or intermarry with the Arabs. Colonel Miles found they were the descendants of a portion of the Persian army which invaded Oman in the tenth century. The isolation of the town and the curious behavior of its people through so many generations would undoubtedly give rise to exaggerated stories in the bazaars on the distant coast, and in this case the origin of the fable may be regarded as fairly certain.

Unfortunately for the romance of the world it seems practically impossible for stories of this character to have the origins novelists would wish. The world is comparatively small to-day. The trail of the explorer is over every land from Paraguay to Tibet. Forbidden lands are entered; hidden cities exist only in the imag-

TRANSPORTATION OF FIBER BY OX CARTS, NORTHEASTERN MEXICO.

THE CULTIVATION AND MANUFACTURE OF MEXICAN SUBSTITUTE CORDAGE FIBER.

Rider Haggard with a theme for one of his best-known novels, "Allan Quatermain."

Similar legends are met with in almost all the less-explored parts of the globe, and they have always certain features in common. The isolated white peoples almost invariably inhabit a mountainous region in a vague "interior"—always the "just beyond"; they hold aloof from the surrounding races; they are seldom seen, and yet are definitely stated to be more civilized

ination of the fictionist. In a period when trains run to Bokhara and the Great African Lakes, when the tourist appears at Khartoum, and Lhasa itself is threatened, there is no room for a mysterious white race. Even the Dark Continent is no longer allowed to have its mysteries. The photographer sits on the battered walls of Kano, the Fulani emperors have passed away.

One may no longer believe in the existence of a strange white people in the heart of Equatorial Africa.

Mr. Rider Haggard's splendid race are probably only the Ba-hima originally discovered by Speke in southwestern Uganda. At least, Sir Harry Johnston claims to have discovered in them the clue to many of the mysterious white race legends found in the Dark Continent. He was engaged in nothing more thrilling than a tour of inspection to Ankole when he came across them. They are of a very light complexion, and are the "aristocrats" of this region. Sir Harry Johnston says they are "obviously descended from a Gala, Somali, or other Hamitic stock," and adds that some of them are more like Egyptians than is the case with Galas and Somalis. Romance disappears before the tread of the explorer. The Dark Continent is dark no more.—Chambers's Journal.

THE DEVELOPMENT OF THE THEORY OF ELECTROLYTIC DISSOCIATION.*

By PROF. SVANTE ARRHENIUS, Stockholm, Sweden.

At first sight nothing seems to be more evident than that everything has a beginning and an end, and that it is possible to divide everything. Nevertheless, the philosophers of antiquity, especially the Stoicist, concluded, on purely speculative grounds, that these opinions are not at all necessary. The wonderful development of science has reached the same conclusion as these philosophers, especially Empedocles and Democritus, who lived about 500 years B. C., and for whom the ancients had already a vivid admiration.

Empedocles professed that nothing is made of nothing, and that it is impossible to annihilate anything. All that happens in the world depends upon a change of form and upon the mixture or the separation of bodies. Fire, air, water, and earth are the four elements of which everything is composed. An everlasting circulation is characteristic of nature.

The doctrine of Democritus still more nearly coin-

FIG. 1.

cided with our modern views. In his opinion bodies are built up of indefinitely small indivisible particles, which he called atoms. These are distinguished by their form and magnitude, and also give different products by their different modes of aggregation.

This atomic theory was revived by Gassendi about 1650, and then accepted by Boyle and Newton. The theory received a greatly increased importance by the discovery by Dalton of the law of multiple proportions. For instance, the different combinations of nitrogen with oxygen contain, for each unit weight of nitrogen, 0.57, 1.14, 1.72, 2.29 or 2.86 unit weights of oxygen.† Between these combinations there is no intermediate proportion. This peculiarity is characteristic of chemistry in contradistinction to physics, where the more simple continuous and gradual transition from one state to another prevails. This difference between the two sister sciences has often caused controversies in the domain of physical chemistry. The occurrence of discontinuous changes and of multiple proportions has frequently been assumed, when a closer investigation has found nothing of the sort.

The law of multiple proportions is the one fundamental conception upon which modern chemistry is built up. Another is the law of Avogadro, which asserts that equal volumes of different gases under like conditions of temperature and pressure contain the same number of molecules. This conception, dating from the beginning of the nineteenth century, was at first strongly combated, and it was its great value in explaining the new discoveries in the rapidly growing domain of organic chemistry which led to its general acceptance in the middle of the past century, after Cannizzaro had argued strongly in its favor.

There were, however, some difficulties to be removed before Avogadro's law could be accepted. For instance, it was found that the molecular volume of sal-ammoniac, NH_4Cl , in the gaseous state was greater than might be expected from its chemical composition. This led to the supposition that the molecules of sal-am-

moniac when in the gaseous state are partially decomposed into ammonia, NH_3 , and hydrochloric acid, HCl . Indeed Von Pebal and Von Than succeeded in showing that this really happens. They used an apparatus that is shown in the annexed figure (Fig. 1). Two coaxial tubes are placed the one inside the other by means of a cork. The outer tube was closed at its upper end; the inner one was open and contained at C a diaphragm of asbestos and above that a piece of sal-ammoniac. The upper end was heated by an air-bath, so that the piece of sal-ammoniac was volatilized. After this a current

FIG. 2.

of hydrogen was led through both glass tubes D and E. Now ammonia diffuses more rapidly than hydrochloric acid; if, therefore, the vapor of sal-ammoniac is partially decomposed into ammonia and hydrochloric acid, we should expect that above the asbestos diaphragm there would be an excess of hydrochloric acid and beneath it an excess of ammonia. This Von Pebal showed to be the case. The hydrogen-current from D showed an acid reaction on a piece of litmus-paper in A, and that from E showed an alkaline reaction on a similar piece of litmus-paper placed in B. It was objected that the decomposition might possibly be caused by the asbestos of the diaphragm, or by the hydrogen. Von Than, therefore, made a diaphragm of sal-ammoniac, and substituted nitrogen for hydrogen, but the effect was the same.

These experiments were performed in the years 1862 and 1864. They were based on the doctrine of dissociation, which was at that time (1857) worked out by Ste. Claire-Deville, and developed by his pupils. From the most ancient times use was made of the fact that limestone at high temperatures gives off carbonic acid, and that quicklime remains. This and similar processes were studied by Ste. Claire-Deville. He found that the same law is valid for the pressure of carbonic acid over limestone and for the pressure of water vapor over liquid water at different temperatures. On these fundamental researches the theory of dissociation was based, a theory which has subsequently played an ever-increasing rôle in chemistry, and whereby a broad bridge was laid between physical and chemical doctrines.

At almost exactly the same time we find in the writings of Clausius on the conductivity of salt solutions the first traces of an idea that salts or other electrolytes may be partially dissociated in aqueous solutions. Buff had found that even the most minute electric force is sufficient to drive a current through a solution of a salt. Now after the scheme of Grotthuss, at that time generally accepted, the passage of the electric current through a solution is brought about in such manner that the conducting molecules, e. g., of potassium chloride (KCl), are divided into their ions, which combine again with one another in the following manner: At first, as the current is closed, the electrode A becomes positive and the electrode B negative. All the conducting molecules KCl arrange themselves so that they

FIG. 4.

turn their positive ions (K) to the negative electrode B, and their negative ions (Cl) to the positive electrode A. After this, one chlorine ion is given up at A and one potassium ion at B, and the other ions recombine, so that the K of the first molecule takes the Cl of the second molecule, and so on (Fig. 2). Then the molecules turn round under the influence of the electric force, so that we get the scheme 3 and a new decomposition can take place. This represents the Grotthuss scheme, that supposes continuous decompositions and recombinations of the salt molecules.

As such exchanges of ions between the molecules take place even under the influence of the weakest electro-

motive forces, Clausius concluded that they must also take place if there is no electric force, i. e., no current at all. In favor of his hypothesis he pointed to the fact that Williamson, as far back as 1852, in his epoch-making theory of the formation of ethers, assumed an analogous exchange of the constituents of the molecules. At this exchange of ions it might sometimes, though extremely rarely, happen that an ion becomes free in the solution for a short time; at least such a conception would be in good agreement with the me-

FIG. 3.

chanical theory of heat, as it was developed by Krönig, Maxwell, Clausius and others at that time.

In the meantime, Bouty, and particularly Kohlrausch, worked out the methods of determining the electric conductivity of salt solutions. In 1884 I published a memoir on this subject. I had found that if one dilutes a solution—e. g., of zinc sulphate—its conductivity per molecule, or what is called its molecular conductivity, increases not infinitely, but only to a certain limit. We may figure to ourselves an experiment performed in the following manner (Fig. 3): In a trough with parallel walls there are placed close to two opposite sides two plates of amalgamated zinc, E and E1. On the horizontal bottom of the vessel there is placed a layer of solution of zinc sulphate that reaches the level 1. The conductivity may be k_1 . After this has been measured we pour in so much water, that after stirring the solution the level reaches 2, which lies as much above 1 as this lies above the bottom. The conductivity is then found to be increased, and to have the value k_2 . Increasing in the same manner the volume by addition of pure water until it is doubled, the level 4 is reached and the conductivity is found to be greater than in the previous case—say k_4 . So we may proceed further and further; the conductivity increases, but at the end more slowly than at the beginning. We approach a final value k_∞ . This is best seen in the next diagrams, which represent the newer determinations of Kohlrausch (Figs. 4, 5).

I explained this experiment in the following manner: The conductivity depends upon the velocity with which the ions (Zn and SO_4) of the molecules (ZnSO_4) are carried through the liquid by the electric force, i. e., the potential difference between E and E1. If this potential difference remains constant, the velocity depends only on the friction that the ions in their passage through the liquid exert on the surrounding molecules. As these, at higher dilutions, are only water molecules, it might be expected that the conductivity would remain constant and independent of the dilution if it be supposed that all molecules, ZnSO_4 , take part in the electric transport. As experiment now teaches us that the molecular conductivity increases with the dilution, even if this is very high (1,000 or more molecules of water to one molecule of ZnSO_4), we are led to the hypothesis that not all, but only a part of, the ZnSO_4 molecules take part in the transport of electricity.

FIG. 5.

ty. This part increases with the dilution in the same proportion as the molecular conductivity k . The limiting value k_∞ is approached at infinite dilution, and corresponds to the limit that all molecules conduct electricity. The conducting part of the molecules I called the active part. It may evidently be calculated as the quotient $k : k_\infty$.

If now this new conception were only applicable to the explanation of the phenomena of electric conductivity, its value had not been so very great. But an inspection of the numbers of Kohlrausch and others for the conductivity of the acids and bases, compared with the measurements of Berthelot and Thomsen on their

* Address before the Royal Institution of Great Britain, June 3, 1904.

† To explain this we suppose, in accordance with Dalton, that the molecules of the different combinations of nitrogen with oxygen contain two atoms of nitrogen and one, two, three, four or five atoms of oxygen.