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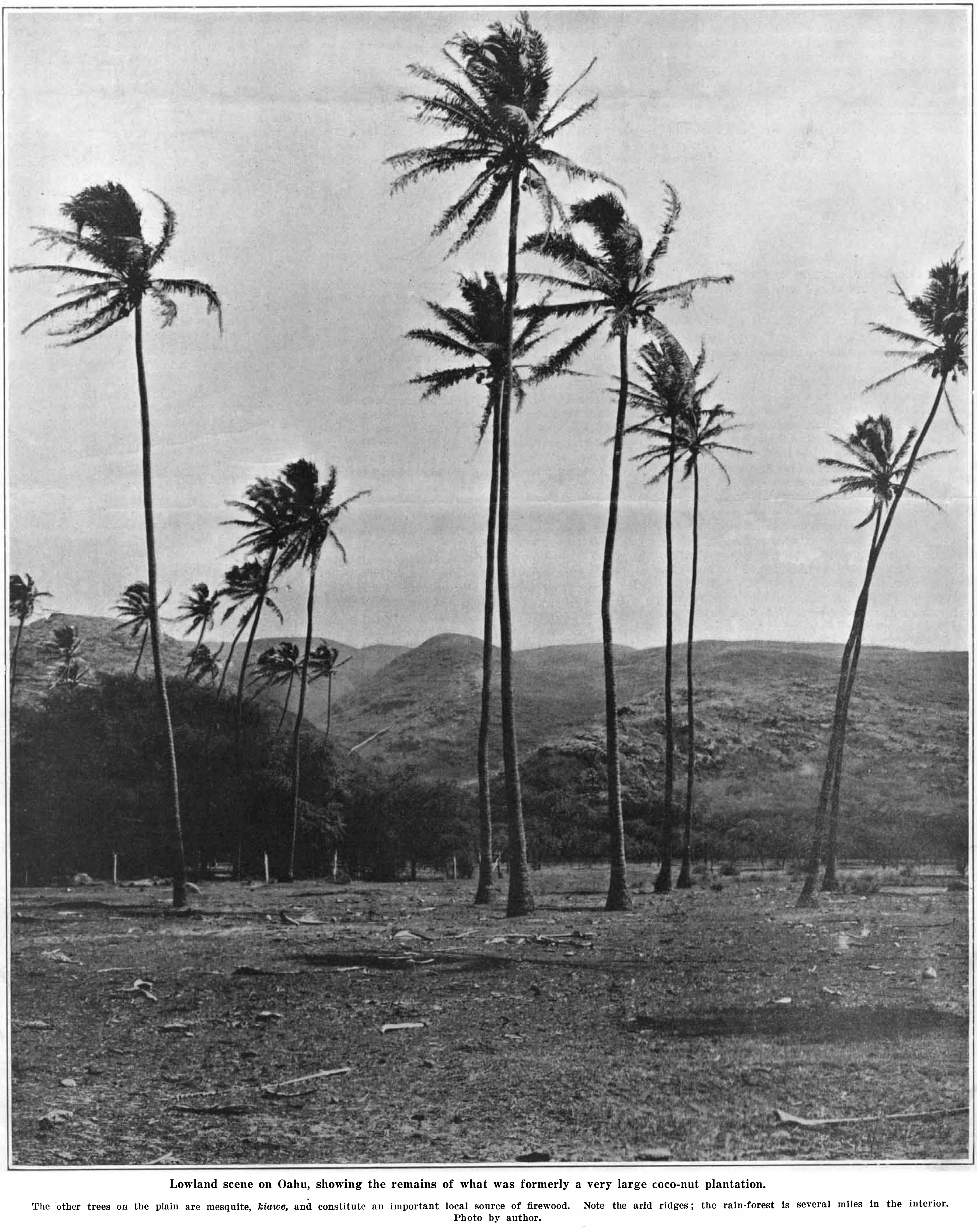


Lowland scene on Oahu, showing the remains of what was formerly a very large coco-nut plantation.

The other trees on the plain are mesquite, *kiawe,* and constitute an important local source of firewood. Note the arid ridges; the rain-forest is several miles in the interior. Photo by author.

THE WOODS OF HAWAII.—[See page 184.]

The Physician and the Weather Bureau*

Advantages to Be Gained by Study of Weather Reports

By Ford A. Carpenter, L.L.D.

HIPPOCRATES, the Father of Medicine, about 600 years before Christ, wrote a strangely interesting and powerful book on "Airs, Waters and Places." "Such a title immediately suggests climatology," says Dr. De Lancey Rochester[1] in a paper read before this association three years ago, entitled "Climatology as Practiced by Hippocrates," and he believes that this was one of the genuine works of Hippocrates the Great.

Hippocrates, in his introduction to this work, says:

"Whoever wishes to investigate medicine properly should proceed thus: In the first place, consider the seasons of the year, and what effects each of them produces (for they are not all alike, but differ from themselves in regard to their changes). Then the winds, the hot and the cold, especially such as are common to both countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities. In the same manner when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and rising of the sun; for its influence is not the same whether it lies to the north or to the south, to the rising or to the setting sun."

HOW THE PHYSICIAN MAY UTILIZE THE WEATHER BUREAU.

Dr. Charles F. Marvin, the chief of the United States Weather Bureau, said in a recent address: "The Functions of the Weather Bureau of the United States Department of Agriculture are so many, so widespread is its scope, that it may be said to encompass practically all fields of life and work." From the very extended nature of the work of the bureau it seems opportune that the medical profession be shown some of the ways in which this service may aid them. The object of this paper, then, is to suggest means by which the medical profession may utilize the vast storehouse of climatic data accessible at Washington and at all weather bureau stations; to prove the readiness of the personnel of the bureau to assist the physician; to present some applications of these data from a layman's point of view and to offer an account of some intensive climatic studies which have been prosecuted by the writer during the past few years.

Every one is familiar with the ordinary health resort advertising literature, a perusal of which gives one the impression that ideal weather conditions only prevail in that locality. Now physicians want facts as to this. They prefer to make their own deductions. They do not want idealizations. The weather bureau presents these facts. The question is, How may these facts be obtained?

THE SOURCE OF METEOROLOGIC DATA IN THE UNITED STATES.

The source of weather data is from the regular stations of the bureau, and from the special or co-operative stations. There are about two hundred of the regular stations and over four thousand of the special stations scattered over the United States.

HOW THE WEATHER MAP MAY BE UTILIZED.

The prime object of the regular stations is to make simultaneous meteorologic observations from which the twice-daily weather map is prepared and weather forecasts are deduced. The duties of the non-commissioned and unpaid observers comprise daily temperature and precipitation observations, so that from both classes of observations it may be possible to construct a satisfactory climatology. So we may say it takes a lot of weather to make a climate.

The regular stations of the bureau, in addition to being clearing-houses for meteorologic information, prepare, twice a day, complete weather observations which are telegraphed to Washington and to certain district centers preparing weather maps. Over a hundred of such stations publish these daily maps. The weather map may be most useful to the physician who keeps track of the storm movements and gathers first-hand information as to existing and coming weather conditions over the United States. He will soon learn to associate stormy, cloudy and comparatively warm by a few simple comparisons to associate stormy, cloudy and comparatively warm weather with those atmospheric whirls called "lows," and fair, sparkling, comparatively cool weather with the whirls called "highs."

As to the further application of this weather map: One of the large California citrus fruit growers times the shipment of his orange and lemon cars so that they will have the advantage of the cool and dry weather of the weather-map "highs" in their eastern journey. There is no reason why a physician should not do likewise and take advantage of the weather map and route his patients according to the great atmospheric movements and thus avoid deleterious weather conditions. It ought to be a common occurrence for the physician to consult the weather bureau as to the railroad altitudes and average weather conditions along their lines so that advantage could be taken of railroad routes having low altitudes, warm winter and cool summer weather.

SOME POPULAR MISCONCEPTIONS RELATING TO CLIMATE AND HEALTH.

Air Pressure Does Not Directly Affect Health.—From the multitude of problems recently presented, the one considering the relationship between air pressure and health appears now to be the most popular. There is considerable misconception regarding this subject occasioned primarily by confusing effect with cause. The mere change in atmospheric pressure from day to day has nothing whatever to do with one's physical well-being. The recent publicity given to this subject during the last few months is simply a revival of a myth laid a generation ago by Thomas.[2] For example, in a recent public bulletin it is stated that when the barometer drops from 30 to 29 inches from one day to the next the human body is relieved of half a ton of atmospheric pressure, with resulting depression of spirits, etc. In the first place, it is quite unusual for the barometer to drop one inch in so short a time, and in the second place, experiments have proved that the influence on the body of variations in pressure is greatly overestimated.

Hann,[3] in his handbook on climatology translated by Prof. Robert De C. Ward, quotes Thomas and says that in experiments with pneumatic chambers, pressure changes amounting to 300 millimeters (over 11 inches in barometric values) a day have been produced without causing any injurious effects on the sick persons concerned in these experiments. Although these experiments were made nearly half a century ago, the pressure myth has persisted, and even this year has found its way into sober-minded periodicals. If a local example is needed to demonstrate further the untenability of the pressure theory, we have only to recall that in Los Angeles, for example, the range of the barometer from day to day averages a tenth of an inch of the mercurial column, equaling the variation experienced when riding in an elevator from the ground floor to the top of office buildings. If there was anything in this theory we would have an "elevator disease" among the elevator conductors who continually experience excessively rapid fluctuations in bodily pressure.

It is rather the fair weather and decreased humidity which accompany rising barometic pressure that elevate one's spirits, or the cloudy threatening weather and increased humidity which accompany a falling barometer that affect the human system. Dr. C. C. Browning[4] noted this when his studies showed that the tuberculous patients became pessimistic and some very unreasonable in their demands during days with little or no sunshine and hopeful of recovery during bright days and moderately low humidity.

Sunshine and Ventilation of More Importance Than Relative Humidity.—I believe that the location of the home or office, the exposure of the living or work room has much more to do with the health of the occupant than whether or not the relative humidity is much below or above normal. Exposure to sunshine and ample ventilation are all important. A friend complained of ill health and blamed the humidity of his office room. He said that it was too damp and asked me to investigate. I took my psychrometer and made a series of observations, finding that there was actually less humidity in his private office than out in the street. I studied the situation and eliminated temperature, humidity, air pressure, etc. Then I turned to air movement, and found the ventilation very bad. I suggested a simple air changing system and my friend regained his health in a few weeks, and was still enjoying his private office when I last heard from him.

Living Quarters and Air Drainage.—Facing houses with relation to natural air drainage is also a most important point in selecting a home. Many a home, otherwise healthful and satisfactory in every other respect, has been abandoned because the architect and owner did not consider the principles laid down by Hippocrates two thousand years ago.

Dr. Estes Nichols, at last year's meeting of this association, said in his paper on "Housing and Its Relation to Climate":[5] "Can any climate rise above its housing conditions? I offer no theories concerning the building of houses, as theories are apt to be overthrown by each succeeding year. I only offer the one fact that has been well established, and that is the vital necessity of plenty of room, as well as plenty of light and air, even to the remotest part of our dwellings."

PROBLEMS FOR THE CLIMATOLOGIST.

Investigation by the Physician.—There are other opportunities for the study of health and its relation to climate, as further transactions of this association show. In the light of augmented data, a few of them might be, for example, the proper selection of sanatorium sites, sensible temperature (wet-bulb thermometer readings) and infant mortality; acute infectious diseases and sunlight (using the sunshine charts of the weather bureau), etc. These are within the scope of the medical profession; the weather bureau, however keenly interested, can assist only with its climatic data.

Intensive Studies by the Climatologist.—There is one phase of the relationship of the physician to the weather bureau in which the balance of proof falls on the weather service, and that is in the matter of intensive climatic investigation. Primarily, owing to the extensive citrus fruit culture in which the United States Department of Agriculture is deeply interested, some of these studies have been taken up in southern California during the past year by the local office of the weather bureau at Los Angeles. Indirectly the mass of data is of much value to the medical profession.

Southern California is about equal in area to Indiana, and within the boundaries of this region may be found all kinds of varieties of healthful weather. This is owing to the mountains, the sea and the desert, as well as the latitude. Scattered over this one portion of California are a dozen stations equipped with thermographs and hygrographs, rain gages, etc. An examination of the curves of temperature and relative humidity as automatically traced is a most interesting study. One of these stations, Los Angeles, is within 10 miles of the sea and shows lower range in temperature and higher relative humidity, and the other, Riverside, which is 55 miles farther east toward the desert, illustrates most clearly the influence of the desert in its range in temperature and low humidity, and above all its remarkably regular oscillations. Such a graphic representation of the diversity of climate within so short a distance would be well-nigh impossible save in southern California.

Intensive Meteorology to the Aid of Colonization and Health.—For the first time in history climatic surveys are being made to determine land values. This is a practical, businesslike commercial application of meteorology to colonization and intensive farming. This climatic survey was begun in June, 1914, on the old Spanish grant of 16,000 acres, the Palos Verdes, which is just south of Los Angeles and between San Pedro (Los Angeles harbor) on the east and Redondo beach on the west. Six complete sets of meteorologic instruments, comprising standard thermographs, hygrographs, rain gages, anemometers, and a photographic sunshine recorder, were erected at various elevations from 100 to 1,300 feet above the sea, and from the seashore to several miles inland. With such intensive study it is believed possible to chart the climate for every 10-acre plot. The climatic charts will show without error not only proper location of dwelling with relation to air drainage, temperature, humidity, etc., but will give positive information as to soil drainage, and all of this in addition to the all-important agricultural and horticultural feature.

WHAT THE WEATHER BUREAU SHOULD DO FROM A PHYSICIAN'S POINT OF VIEW.

In closing this paper I feel that a physician friend who has long practiced medicine in one of the towns

* From a paper read before the thirty-second annual meeting of the American Climatological and Clinical Association, San Francisco.

[1] Rochester, De Lancey: Tr. Am. Climatol. Assn., 1912, xxviii.

[2] Thomas, quoted by Hann: Beitr. z. Allg. Klimatol., Erlangen, 1872.

[3] Hall, M. Y: Beitr. z. Allg. Klimatol., Erlangen, 1872.

[4] Browning, C. C.: Tr. Am. Climatol. Assn., 1913, xxix.

[5] Nichols, Estes; Tr. Am. Climatol. Assn., xxx, 17.

in California has clearly stated some of the ways the physician may properly claim the assistance of the weather bureau. This eminent physician says:

"I believe the field has been but little explored. We physicians are guilty of many things; among them is guessing. If the United States Weather Bureau will prove some of this guessing true or false it will add one more good thing to its past fine record. I think that the time is near at hand when our health officers will be required to be specialists. They will then have the time, the special training and other equipment to go into the subject in conjunction with your bureau and give us some scientific findings. I think the State should be plotted, showing the real atmospheric conditions of all localities and showing the influence on the functions of the body. Whether the old east wind of Boston is accountable for all of the vile things charged to it or not nobody really knows, but it should be investigated. That altitude, temperature, humidity, prevailing and unusual winds have much effect on many individuals there is no doubt. The nasal and pulmonary mucous membranes are constantly affected by atmospheric conditions. Locally I have observed that semi-chronic bronchial coughs that do not yield readily in the city will often clear up in a few hours in the mountains and foothills east of the city. A congested nasal mucous membrane that will kick up a rumpus much of the time in the mountains will disappear promptly at a lower elevation near the coast. Some patients with bronchial asthma that is incurable in the business section of the city will be very comfortable a short distance out of town and in a higher, drier location. Two hot, dry days last month have been charged up with some rather serious pulmonary conditions in aged people. These are a few instances of hundreds coming to my mind that I have observed in my years of practice. The subject should be worked out by a union of effort of the Weather Bureau and the medical profession."

Alcohol in War*

By Dr. Alexander Elster, Berlin

During the period of mobilization, as indeed during the present days, when the whole world was surprised that the use of alcoholic drinks was prohibited in Russia, it became evident that the long-expected struggle against alcohol had become of great importance. The smooth course of the German mobilization, as well as the quite unexpected military strength of Russia, could be charged to the account of abstinence from alcohol or the restricted use of it, if one cared to look at the matter from such a point of view. In times of crisis, when no one knows what may be expected of him, it is a well known scientific fact which does not require to be further elaborated, that alcohol reduces the capacity for work. But this fact seems to have been given a severe blow at the moment when the German Crown Prince sent out the famous telegram in which he requested the free use of spirituous drinks, namely, rum and arrak, for the troops. The liquor interests looked upon this request as inspired, made a great advertising point of it, and triumphed in the extreme importance of alcohol, to their financial interest. Meanwhile the chamberlain of the Crown Prince had specifically announced that the attitude of the Crown Prince on the question of alcohol was in agreement with that of the opponents of alcohol, who had organized into the German Society against the mis-use of spirituous drinks, and that it was not his wish to have rum and arrak sent to the troops as a regular ration, but for medicinal use at definite times and under definite circumstances, such as during extraordinary exposure to wind and weather, in which the occasional use of a stimulating drink might be proper. There was only said, then, what no opponent of alcoholism would dispute, namely, that under extraordinary circumstances, the limited use of alcoholic drinks as medicine is permissible. When a physician writes then that nothing could be done in the field without alcohol, the remark has some justification, even from the point of view of strict prohibition. From this point of view we might also consider the newly formed army administration control of the sale of beer, since it has become necessary in order to insure a supply of beer for the troops in districts in which the water is not free from germs, and therefore may be unhealthy, to establish some regularity in its distribution. Supposedly only the urgent needs will be supplied, small in comparison with the former habit of beer-drinking, which will never be the same again.

It has been definitely established that criminality is increased among troops, back of those in the front lines, by long inactivity and increased use of alcohol, and it has been shown beyond a doubt in other wars that mental disorders in the field are not alone due to the extraordinary psychic pressure, although this is an important cause, but is also considerably extended by alcoholism. So, for example, in the Russo-Japanese war, during which hysteric-neurasthenic delusions were prevalent among the rear guard, alcohol was the chief contributor. In the Russo-Turkish war, which terminated in victory for the Russians and against the Turks, largely because of help from Roumania, according to the testimony of surgeons who were present, it was largely due to the temperance of the Turks and their regularity in eating that they were able to withstand the Russian superiority so long in spite of their lack of weapons, equipment and proper provisions. Also after the truce of St. Stephano, typhus and dysentery caused great devastation among the victorious Russians, while the Turks lost scarcely any men on account of sickness.

Realization of such marches as 60 kilometers in a day (37.2 miles) or greater distances, are possible only when the consumption of spirituous liquors is strictly forbidden. The same conclusion was reached by Head Surgeon Prof. Dr. Bischof (in the journal *Der Alkoholfrage*, vol. 4, 1914) during the Austrian maneuvers in 1903 and 1904, and he definitely established that for sun stroke (the worst disease of the army), the chief cause among a number was alcoholism.

It may be seen that all of this is well known in military circles from a great number of army orders, one of the most notable manifestations of which came from commanding Gen. F. von Bissing at the time he took command of the seventh army corps. This was found in the army orders after the outbreak of the world war and before von Bissing had been called into the general government of Brussels. In an order issued in the middle of October the commander requested even the inhabitants to remember that "it would be an offense to the wounded if their health was endangered by the importation of any intoxicating liquor, and that anyone doing so was liable to punishment." Toward the end of October he mentioned Section 416 of the sanitation order, according to which alcohol was at first a stimulant, but the use of larger quantities soon produced exhaustion. These circumstances show that temperate soldiers are best able to withstand the hardships of war. Mention must be made briefly of another order, also issued toward the end of October, which was as follows: "This has lately been mentioned many times in the *Telegram* in a prominent place; how much it has been mis-interpreted and taken advantage of for commercial reasons is well known. On nights when dark clouds roll up over the barracks and trenches or the cold penetrates the clothing a sip of cognac or a hot grog has been allowed rather than water or lemonade. No one begrudges it to the troops, and gifts of arrak, rum, or other liquor have certainly not been forbidden by the commanding officers. But of far more importance than the beneficial influence and the pleasure in single instances is the larger general interest of the army and the conduct of the war, the spirit and discipline of our troops. And in these interests the use of alcohol must be vigorously excluded. Then let public opinion take what course it will, and the liquor interests bring such evidence as pleases them: as long as military necessity exists, let it be known what stand the military authorities have taken. Here, then, once for all, let it be said that if the officials of the military staff are to be held responsible for the welfare of the troops, all classes of people are essentially a party to this responsibility."

It is well enough understood that these things have been known in the German navy for a long time. Indeed in no other organization is alcoholic temperance so well understood and so energetically carried out as among the marines. With them such a rule of prohibition is relatively easy to enforce, for they know so well the great importance of exact work and methods and of what benefit is the permanent and clear control of thought and will power. The well known effect of the use of alcoholic drinks on the bodily and mental capacity has made a more lasting impression on the members of the navy than upon most of the other classes of people.

But the alcohol question has assumed during the war another far more important significance. This is its relation to the insurance of an adequate food supply for the people. For medicinal use alcoholic beverages are usually in the form of wines—in distinction to beer and spirits—so that from the standpoint of food supply wine is to be considered in a somewhat different light from beer and spirits. For the manufacture of the latter drinks materials are used which are foods, such as potatoes and grain, and which are far too important a source of nourishment to be used for such a purpose, since in the process of fermentation a large part of the nourishment is converted into poison. Privy Councillor Sering has favored the suppression of brewing, and Prof. Zuntz has expressed the opinion that everything which is not directly concerned with the supply of human food must be stopped in order to prevent the waste of anything at all which could serve as nourishment. During the past months of the war we have squandered in the manufacture of beer (a luxury) a quantity of grain sufficient to supply daily bread to about fifteen million men; and to-day, though regulations have reduced this to about 60 per cent, the daily consumption is still about eleven million liters of beer, which is equivalent to the grain required daily for eleven million men. According to Dr. R. Murdfielt the loss due to the manufacture of alcoholic beverages is one seventeenth of the total available food supply, and 40 per cent of the total production of barley is used for making beer. According to this same authority the equivalent of about 380 million liters (about one hundred million gallons) of absolute 100 per cent alcohol is concerned in the manufacture of spirituous drinks. Three liters of alcohol per capita are manufactured from potatoes. In this process barley malt is added to promote the formation of sugar, and in quite considerable quantities. Since for 100 kilogrammes of potatoes 5 kilogrammes of green malt are required, about 1,400,000 kilogrammes (1,500 tons) of barley are used for this alone. Sixty per cent of the raw material is converted into alcohol. In the tax-year 1912-13 alone 2,700,000 tons of potatoes were used by breweries for spirituous liquor, that is, about 6 per cent of the total crop according to statistics, in addition to 66,000 tons of barley and other flour materials, and about 700,000 hektoliters (2,000,000 bushels) of fruit and turnips. For a liter of beer (2.11 pints) 250 grammes of barley are required, which is equivalent to the daily allowance of flour per person established by the Government. It should be evident that brewing is wasteful from this fact alone, entirely apart from the fact that the 250 grammes (8.8 ounces) of grain required for a liter of beer would make 200 grammes of flour, from which at least 300 grammes of bread (10.6 ounces) could be made.

One is forced to see in this wasteful use of food products an injustice to the people. At a time when the Russian supply of grain is not available and we are forced to conserve as carefully as possible not only the food supply for men, but for animals as well, it appears of the greatest importance to check thoroughly the enormous waste of nourishing foods entailed in fermentation and brewing. On the other hand, these regulations call for a consideration of the welfare of a large number of trade people, though they are not entirely objects of sympathy, for they still have to manufacture alcohol for industrial purposes as before. It is still a difficult question for the breweries and saloon employees, however. But since the facts which have been mentioned do not apply to wines in general, it might not be unreasonable to expect proprietors of saloons to concentrate their activities on wines during the war time, since beer is no longer to be had, or at least only at a very high price. The breweries may well consider for themselves a decreased force of employees and a curtailed rate of production, for we live in a time when the interests of an individual must be sacrificed to the general welfare of the State, however difficult or oppressive this may be in some cases.

The experience of the war may profitably open the eyes of many who were formerly of another opinion to the effect of the alcohol question on German culture.

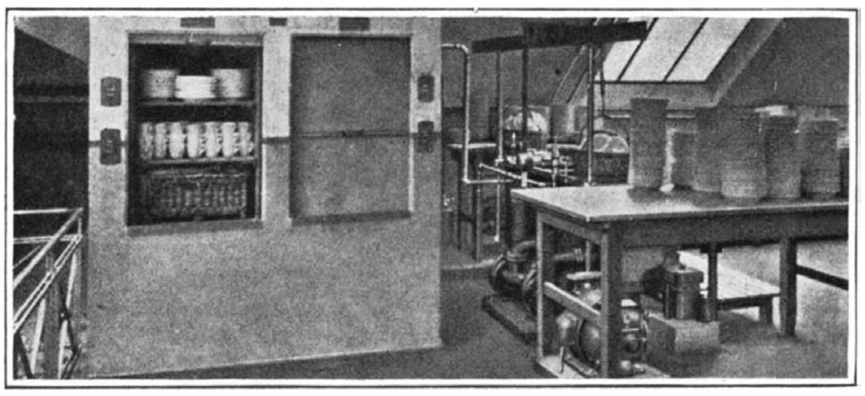
* From *Weltrundschau*.

Electrolyte for Pocket Lamp Batteries

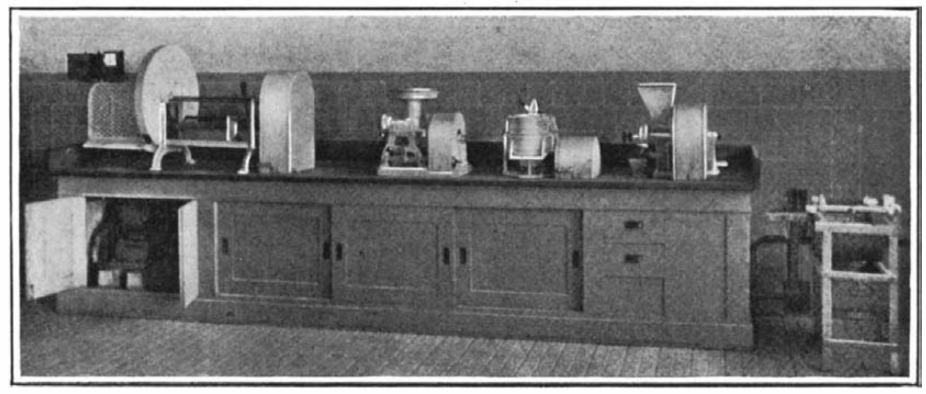
The following instructions are given in a German publication for preparing the electrolyte used in the batteries for the ordinary pocket flash lamp:

One hundred and forty grammes of well-powdered salammoniac, 40 grammes of zinc chloride, 10 grammes of ammonium sulphate are mixed together in a porcelain bowl with 10 grammes of thick refined glycerine. The mixture is then covered in small quantities with distilled water at a temperature of 40 deg. Cent. and energetically stirred until the materials are dissolved into a concentrated solution. This mixture is allowed to soak into the binding material, and the paste so formed is filled into the cells, which are closed with a paraffined card top sealed with bottle-wax. In the cover two small glass tubes are provided for the escape of such gases as are generated within the cell. In compounding the electrolyte calcium acetate can be mixed with advantage with equal parts of the salammoniac. Such a solution possesses excellent conductivity, is hygroscopic, and does not crystallize or creep.

Binding materials used for making a paste of the electrolyte are glass-wool, sawdust, gelatine, starch, kieselguhr and water-glass. Ordinary flour, either wheat or rye, is, however, most generally used.



Dish washing apparatus and drying oven operated by electricity.



Electrically driven meat slicer, vegetable cutters and coffee grinder.

The World's Largest Electric Kitchen

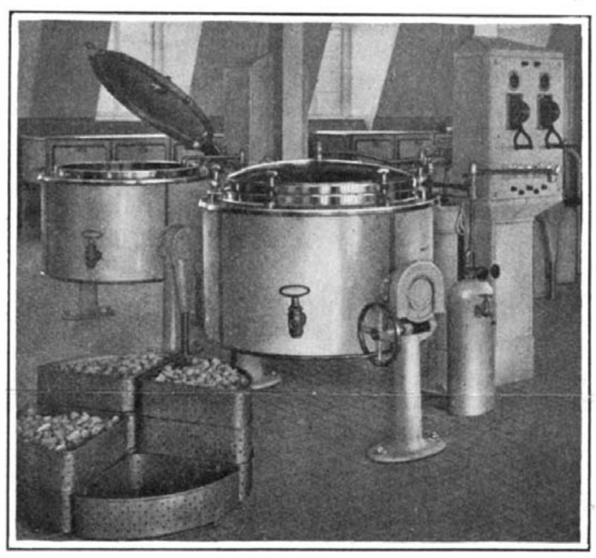
That Easily Feeds Thousands Each Day

THE largest electric kitchen in the world, in operation at Siemensstadt, near Berlin, Germany, is shown in the accompanying illustrations. This remarkable electric kitchen has a capacity for serving three thousand persons in four groups, of from seven to eight hundred workmen in each group, between the hours of 12 noon and 2 P. M., one half hour being allowed for each group. The electric cooking installation was decided upon after a careful study of the use of gas, coal and steam cooking in the various plants of the Siemens-schuckert Werke in other cities and other suburbs of Berlin, where the office forces as well as the workmen have been served with meals for a number of years during the noon hour.

This new electric kitchen and restaurant at Siemensstadt is the most thoroughly equipped electric cooking installation in the world, as well as the largest, being provided with a modern cold storage and refrigerating plant operated by electric compressors, electrically driven kitchen utensils of every description, including coffee grinders, knife sharpeners, meat slicers, and vegetable cutters as well as electric potato paring and slicing machines. The electric cooking apparatus includes novel designed soup kettles and boiling vessels, varying from fifty liters capacity to four hundred liters. These kettles, shown in the accompanying photograph, have insulating shells for retaining the heat as well as a novel system of utilizing electrically heated oil between the casings, similar to the system of double-boilers ordinarily using water for cereal cooking.

These oil-heated vessels have the electric heating elements in the bottom arranged with two and three sets of coils providing for 12, 24 and 36 kilowatts, as desired. These kettles are tipped by means of levers and also by wheel and worm gear in the case of the larger devices. The roasting and baking equipment is of special interest and may be noted in the background in one of the illustrations. The baking ovens require a current of 8 kilowatts, and measure 3,400 millimeters long, 1 meter wide and 1,250 millimeters high. The electric broilers are mounted on three tables and measure 400 millimeters by 600 millimeters, with a depth of 65 millimeters, each requiring 7 kilowatts. The capacity of these broilers is 200 cutlets per hour, while the total capacity of this kitchen is 3,000 portions for each noon-day meal.

The electric coffee vessels have a total capacity of 500 liters, and vary in size from 75 liters, capable of serving 300 cups of coffee, to 150 liters, having a capacity of 700 cups of coffee per hour. The smaller coffee



Potato boiler, with electric oil heating jacket.

pots of 75 liters require 12 kilowatts, while the larger ones use 18 kilowatts. The hot water is supplied from electrically heated vessels at three temperatures, automatically controlled to 40, 60 and 100 deg. Celsius. The electric water heating boilers vary in size from 1.5 cubic meters to 6.5 cubic meters, and the kitchen is equipped with a great variety of other cooking utensils which can hardly be mentioned.

The electric dishwashing apparatus is most complete with electrically operated pumps for circulating the water through the washing machine, electric conveyors and electric drying oven. The kitchen is well ventilated by electric fans mounted in the wall and window casing for drawing out the fumes from cooking.

The kitchen and serving room are on the sixth and seventh floors of the building and are well lighted with windows and electric lighting equipment. The electric current is supplied from the central station at 6,000 volts, 3-phase, stepped down to 350 volts by a transformer and converted by a motor generator to a direct current of 220 volts for use in electric cooking service. The 220-volt, direct current is supplied by the 3-wire system to the electric broilers, ovens, kettles and other cooking apparatus as well as the motor driven appliances.

The cost of electric cooking in this installation is said to be extremely low, not exceeding 2.15 pfennig ($\frac{1}{2}$ cent) per capita per day, including the total current consumption for all purposes, while for cooking alone the cost does not exceed 1.53 pfennig (1/3 cent) per capita per day. It has been found in the various other plants of the Siemensschuckert Werke using gas, steam and coal that the cost varies from 1.25 pfennig ($\frac{1}{4}$ cent) as a minimum to as high as 2.47 pfennig (0.6 cent) per capita per day. During the month of February, the total current consumption for the electric kitchen was 0.534 kilowatt-hour per capita, while the daily current consumption for cooking alone was 0.387 kilowatt-hour. During the month of April, the total current consumption was 0.35 kilowatt-hour per capita per day, while for cooking alone the daily consumption of current per capita was 0.220 kilowatt-hour.

Very careful records have been kept of the cost of electric cooking per capita, for boiling and baking potatoes, boiling and roasting meat, broiling beef steak and pork chops, and cooking lamb, mutton and fish, as well as vegetables of all kinds, and the making of pastry, baking of bread, cakes, and rolls, all of which information is of great interest, but cannot be given in detail in this article.

Using the American Ephemeris to Make Your Own Almanac*

By Frederic Campbell, Sc.D.†

SEND one dollar to the Superintendent of Documents, Government Printing Office, Washington, D. C., and you will obtain a copy of "The American Ephemeris and Nautical Almanac" for the current year, or for either of the two following years that you name. The volume for 1915 has 742 pages, made up of such masses of figures as may well appal the average amateur astronomer. The book is invaluable for professional astronomers and for navigators. But no effort has been made to make it popular, and to wish your dollar back will be very natural after a cursory examination.

While far more than 99 per cent of the matter contained will be of no service whatever to the amateur, yet in the remaining less than 1 per cent there is very valuable and interesting information, which can be dug out without much labor. If one take a diary or date book, and fill it in from this source, he will soon discover that he is constructing his own almanac, to which he can make constant reference as the days and months go by.

To the following items he will want to give attention:

1. The phases of the moon, day, hour and minute, Greenwich time, which he must translate into local time, an interesting process.

2. The moon's perigee (nearest) and apogee (farthest), also in Greenwich time.

3. The moon's librations, east and west. These he will have to obtain from some other source, like Jayne's Almanac, which is to be had at the drug stores for the asking.

4. The moon's farthest north and south. These may be determined from the tables giving the moon's declination hour by hour, or from the moon's longitude and latitude table.

5. The moon's nodes, ascending and descending; this to be obtained from auxiliary almanac as above.

6. The moon's age; to be counted, day by day, from the day of new moon.

7. The disks of Mercury, Venus and Mars; found in the tables showing extent of illumination of the disks in percentages.

8. The light-time of Mars and Jupiter, from tables showing how long their light takes to travel to earth at different times.

9. Aspects of Jupiter's four principal satellites, graphically presented, their groupings, also missing satellites, etc.

10. The stellar magnitude of various planets at different times, enabling one to compare their changing brilliancy with that of leading first-magnitude stars.

11. Occultations of planets and of principal stars that may be selected from the large number occulted, determined by the magnitudes given.

12. Eclipses. Not only are the facts given, but maps presented, showing the regions affected in case of solar eclipses. The total eclipse of the sun, visible in America in 1916, is soon to be reckoned with.

13. Times of rising and setting of sun and moon, to be obtained from auxiliary almanac. Day's length determined in connection therewith.

14. Various passing phenomena, known as "planetary configurations," conveniently covering two consecutive pages, and showing: *a*, conjunctions of planets with each other; *b*, conjunctions of planets and moon; *c*, planets' greatest brilliancy; *d*, conjunction of planets with sun; *e*, planets at quadrature; *f*, planets at opposition; *g*, planets' perihelion and aphelion; *h*, earth's perihelion and aphelion; *i*, planets' nodes; *j*, Mercury's and Venus' greatest elongations; *k*, planets stationary; *l*, solstices and equinoxes; *m*, Mercury's and Venus' greatest heliacal latitude north and south.

The process of making one's own almanac in this manner the writer finds to be of great interest; unconsciously one is familiarizing himself with many things about the heavens; and his self-made almanac, growing day by day, will mean more to him than any other.

* From *Popular Astronomy*.

† Former president Department of Astronomy, Brooklyn Institute.

A Non-Conducting Coating

A CHEAP coating for low pressure steam pipes, described in *Power*, consists of sawdust mixed to a thick paste with starch made from one part rye and two parts wheat starch. Copper pipes should have a couple of priming coats of fire clay mixed thin with water. The pipes are first wound spirally with string, to give a grip for the first layer, which is put on a quarter of an inch thick, and when this is set additional layers are added, with a weather finish of coal tar.

Some Unsolved Problems of Photo-Chemistry*

The Chloroyphyll Problem

By Harry A. Curtis, Ph.D.

CHEMICAL action may easily be caused to produce light; indeed, artificial light was produced in no other way until modern times. To derive chemical actions by means of light is, however, a process about which but little is known, although it is a process which every growing plant successfully accomplishes.

The photo-chemistry of plant assimilation is now receiving much attention. In this process, carbon dioxide and water are the raw materials, carbohydrates the chief of the finished products. Between these two systems, carbon dioxide plus water on the one hand, and carbohydrates on the other, is a big gap in energy which the plant crosses by utilizing the energy of sunlight. The active agent in this transfer, the chief engineer if you please, is a certain green substance called chlorophyll, but beyond the fact that the goods are delivered on the proper side of the gap, not much is known about the process.

It is possible to manufacture carbohydrates from water and carbon dioxide in the laboratory. It is even possible to do this by means of light without the aid of chlorophyll. Here, however, an unfair advantage must be taken by using light of shorter waves than occur in sunlight. It seems probable that chlorophyll plays the part of a photocatalyst, by the aid of which plant assimilation may proceed in light of much lower waves than could otherwise be utilized. There are other examples of such photocatalysis or "optical sensitization," of which a familiar one is the use of certain dyes to extend the sensitiveness of the photographic plate into the yellow and red region of the spectrum.

In recent years much progress has been made by Prof. Willstatter and his students toward solving the "chlorophyll problem" but much remains unknown about this photo-chemical process to which all the coal beds on earth owe their origin. Could we but learn to "speed up" the process of plant assimilation, as we can speed up the process of combustion, sun-power would certainly become a factor in the industrial world.

THE LAWS OF PHOTO-CHEMISTRY.

A study of the kinetics of photo-chemical reactions is complicated by a number of troublesome factors, and progress in this line has been slow.

In order to be photo-chemically active, light must be absorbed. The fact of light absorption by a system, however, does not necessitate chemical action, since the light absorbed may be converted into heat. When photo-chemical action does occur, the degree of absorption is an important factor in determining the mechanics of the reaction. It appears that in reversible reactions with a large absorption of light, the velocity of the reaction becomes simply proportional to the amount of light absorbed per unit time, which is obviously a law analogous to the Faraday law of electrolysis. With an irreversible reaction having a small absorption, however, the mass law may be applied with a few modifications.

But little is known about the catalysis of photo-chemical reactions, which is not surprising in view of our almost complete ignorance as to the nature of catalysis in general.

The effect of temperature on photo-chemcial reactions is much smaller than on other reactions. An increase of temperature of 10 degrees will usually double or triple the rate of an ordinary reaction, while the same increase of temperature seldom multiplies the rate of a photo-chemical reaction by more than one and a half, and in many cases has very little effect at all. It is well known, for example, that a photographic plate is nearly as sensitive at the temperature of liquid air as it is at ordinary temperatures.

The whole subject of photo-chemical kinetics is as yet much confused, and a great deal of quantitative experimental data are needed. There is undoubtedly some relationship between the chemical reactivity of a substance under influence of light and its molecular structure, just as there must be between its color, itself a photo-chemical phenomenon, and its molecular structure.

COLD LIGHT.

The total energy radiated by a body is proportional to the fourth power of its absolute temperature (Stefan-Boltzmann law). This energy, however, is not evenly distributed in the spectrum, but for each temperature there is a characteristic distribution curve having a maximum at a certain wave length. As the temperature is raised, this maximum shifts toward the region of shorter waves. We are all aware of the qualitative operation of this law, that when the temperature of a body is gradually raised, heat waves are at first emitted, and later light waves of the longest wave length visible, i. e., red light. Obviously all "perfectly black bodies," i. e., such as follow the Stefan-Boltzmann law, would grow "red hot" at one definite temperature, while actual bodies, which differ somewhat from the ideal black body, will become red hot at temperatures which differ somewhat, but are not far from that of the ideal black body. All incandescent lamps operate on this principle, and the radiations produced are by no means limited to the visible regions of the spectrum, so that a considerable portion of the electrical or chemical energy used in the operation is wasted so far as the production of light is concerned.

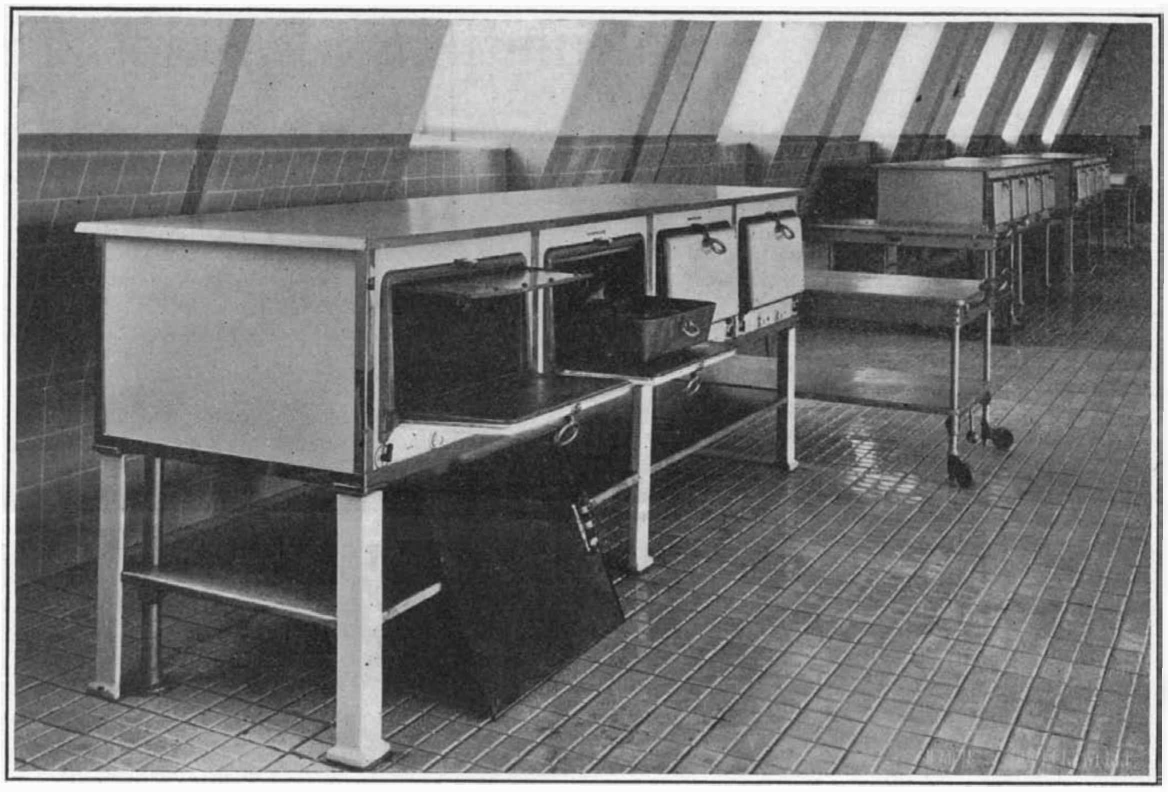
So much for the ordinary emission of light. There are many cases known, however, where light is emitted from a body whose general temperature is far below red heat. Several kinds of luminescent bacteria are known; the fire-fly and glow-worm are common; phosphorus glows when exposed to air and moisture; fluorite emits a bluish-green light when gently warmed; certain sulphides will glow in the dark after a preliminary exposure to light; many chemical reactions are accompanied by the production of light at ordinary temperatures; crystallization is often accompanied by tiny flashes of light, and a similar phenomenon is to be observed when certain crystals are crushed.

In all these cases the light is produced at temperatures which are several hundreds of degrees below that which would be required by the ordinary laws of radiation. This phenomenon, the production of "cold light" by any of the above named means, goes under the general name of luminescence. The mechanism of the process or processes is unknown.

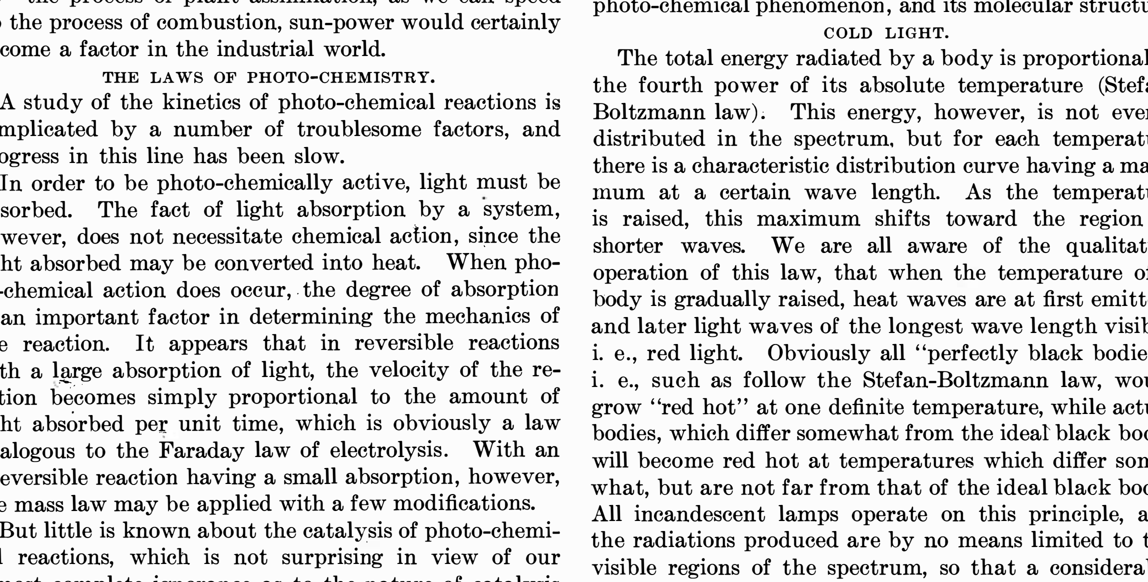
That all forms of energy are mutually and quantitatively interconvertible is one of the axioms of physical science. The practical problem of converting one form into another is, however, a problem of gigantic proportions, one which has claimed the attention of men from earliest times. That the problem has in part been solved, is evidenced by the tremendous operations of modern industry. It is perhaps not too much to say that modern civilization could not have been attained had man not learned to transmute energy. There is, however, little room for pride in the achievement, for at every transfer much of the valuable free energy is spilled into the great dead-level ocean of heat to which every form of energy seems destined to revert ultimately. Engineers talk much of "efficiency" and seem to feel that the word lends a luster of achievement to their discourse. The real fact is that the word "efficiency" hides the chagrin with which they deliver at its destination so small a fraction of the total amount of energy which they bravely essayed to transform.

It so happens that some of the transformations are much easier to make than others; mechanical energy may be transformed into electrical energy, and *vice versa*, with but little loss, while in the transformation of heat energy into mechanical energy but little is saved. Among those transformations in which least skill is shown is the production of light. If produced through the chemical process of combustion, but a small part of the chemical energy liberated becomes light; the various electric incandescent lamps do better, but even here a considerable portion of the electrical energy is spent in producing waves of radiant energy far too long to be seen. To transmute chemical energy wholly into visible radiant energy is a problem which has so far utterly defied practical solution. The photo-chemist is still struggling with the problem. If therefore he is discovered hovering about some swampy place with a fine-mesh butterfly net, be sure that he is only pursuing common fire-bugs, although the results so far achieved in this line would indicate that he has captured only will-o'-the-wisps.

* From a lecture delivered before the Teknik Club, Denver; republished from the *Metallurgical and Chemical Engineering.*



Compact and conveniently heated ovens.



Hot tables and kettles for making soup and boiling vegetables.

Electric Power in Alaska

COMMENT has recently been made on the limited application that has been made of electricity in Alaska, where there are so many directions in which it could be applied with advantage. There are a great number of streams that are capable of furnishing power for the generation of electricity at a slight expense, and this electricity could be utilized to replace much of the expensive labor that is everywhere necessary in mining operations. One of the latest applications of electricity for this region that has been suggested is for thawing the frozen gold-bearing gravel, and for this purpose cheap electricity is claimed to be especially well adapted.

Calculations for Ships' Forms*

What Model Experiments Show in Regard to Resistance, Propulsion and Rolling of Ships

By Rear Admiral D. W. Taylor[1]

ALL ship calculations proper are made from the complete lines, namely, sheer, half-breadth and body plans, or from special calculation plans derived from the lines. But in order to get out the lines in the first place, the usual methods of trial and error involve a large amount of calculation. Such drudgery could be largely reduced by the determination, once for all, before delineation, of each line to be drawn, provided this determination did not bring in too much drudgery of its own. This leads to the use of mathematical formulæ of such nature and with such optional coefficients as to enable us to choose in advance the kind of line we wish, with the certainty that the displacement or area will be what is desired. Some devices or formulæ for lines propose to go further and give lines resulting in ships particularly easy to drive, or whose resistance can be calculated from coefficients depending upon the formulæ. Such a proposition, for instance, was put forward by Herr Bauer in 1914 before the Schiffbautechnischen Gesellschaft.[2]

For some fifteen years, at the United States Model Basin, there have been used mathematical formulæ, not with the idea that they give lines of minimum resistance, but simply to obtain lines possessing desired shapes. Dealing with a large number of models annually—one hundred and fifty distinct models in some years—even after allowing for the fact that many of them are from complete sets of lines furnished independently or derived from other lines by expansion or contraction, it would be practically impossible to accomplish the work with the force available if it were necessary to draw each new set of lines by the trial and error method. By present methods, after a little study and practice, a competent draftsman can get out a complete set of lines giving exactly the displacement desired, using nothing from any previous vessel, in not more than five days. Most models, however, are modifications, in a desired direction, of some previous lines, and can be gotten out in less time. Practically all United States naval vessels designed during the last ten years have had mathematical lines.

Formulæ for lines should be as simple as possible and involve the fewest possible optional coefficients. This for the reason that these quantities are not wholly independent, and the more complicated the formulæ and more numerous the optional quantities, the more complicated the relations between the optional quantities which must be considered in obtaining a fair form. For water lines and curves of sectional area we use a fifth-power parabola as the primary formula. For such a line, of given half-length and half-beam, we may choose, at will, the coefficient of fineness, the tangent or angle of inclination at the extremity, and the curvature amidships. The inclination at the midship section is in every case zero, and the water line must have the proper half-breadth at the midship section, which, of course, is not necessarily at the center of length.

For fine sections, with sectional coefficients below 0.7, or thereabout, a fourth-power parabola is used, the optional quantities being the coefficient of fineness of the section, the flare or tumble-home of the section at the water line, and the dead-rise at the keel. For full sections, with sectional coefficients above 0.7, or thereabout, we use an arc of a very well-known curve, namely, the common hyperbola. This can be made to give sections practically identical with those from the fourth-power parabola for coefficients in the vicinity of 0.7, so we can pass from one formula to the other without any difficulty. For these full sections the only optional quantities are the coefficient of fineness and the flare or tumble-home at the water line. The dead-rise follows from the nature of the curve, but it is found in practice that for the full sections for which the hyperbola is used, and for ships' forms as they are, the dead-rise angles resulting from the hyperbola are quite satisfactory. The trouble with mathematical formulæ for sections and water lines is that in addition to giving us the curves we want, they are capable of giving us a great many curves that we do not want, and before they can be used with satisfaction, it is necessary to determine how to use the optional coefficients in order to obtain, at will, curves such as are wanted.

When steam navigation entered upon the rapid development dating from the middle of the last century, it became necessary that former crude ideas as to the resistance of ships and methods of determining the power required to drive a given ship at a given speed should be replaced by ideas and methods more in consonance with facts.

In 1860, or later, we find leading authorities who considered that the whole resistance of a ship was due to surface friction and that for properly formed ships the wave resistance was negligible. All such ideas have now been discarded, and the present accepted ideas as regards resistance of ships are based entirely upon the work done by William Froude and his successors in model tank experiments. Although it is more than forty years since Froude built the first model tank in his garden at Torquay, England, and published most important results of experiments made there, it is only since a comparatively recent date—say the beginning of the present century—that model tanks and their results have been generally accepted as ordinary tools of the naval architect thoroughly to be relied upon. Here and there a skeptic may exist to-day, but the law of comparison as applied by Froude is now generally accepted.

At the United States Model Basin, during the last fifteen years, the Froude methods have been applied to the models of some 189 United States vessels, having a total displacement of about 1,163,874 tons and a value, or cost when new, of about $443,000,000. In the cases of two vessels, only, have the results of the trial of the full-sized ship differed materially from what was to be expected from the model results. This was really one case, as the two vessels were sister ships. The probable cause of the discrepancy has long been known, although it acts so seldom in practice that it is apt to be forgotten.

The law of comparison, strictly speaking, requires that not only must the speed of the full-sized vessel be to the speed of the model in the ratio of the square root of their linear dimensions, but that the pressure around the two must be in the ratio of the linear dimensions. It so happens, however, that pressure does not affect materially the resistance due to surface friction and to the formation and dispersion of waves for either model or ship. As regards the third recognized element of resistance, namely, eddying, the theoretical pressure conditions must be complied with, if the eddy resistances of model and full-sized vessel are to follow the law of comparison; but in nearly all vessels the eddy resistance is not only a small factor, but consists of eddies behind struts, stern post, etc., which are comparatively little affected by pressure. But in vessels with exceptionally full sterns, we may have eddies under the quarters, with accompanying increase of resistance; while corresponding eddies do not appear in the model, although they would appear if the pressure around the model could be reduced to scale. This was apparently the condition in the case of the two vessels above referred to, which required more power than expected to obtain their designed speed.

I would not be understood as stating that the resistance of a full-sized vessel can be determined in advance with minute accuracy by model basin experiments, or by any other method now known. As a matter of fact, the resistance of any vessel is largely due to frictional resistance. For most vessels, this factor is decidedly predominant, and we determine the frictional resistance of the surface of a large vessel; ments made by Froude forty years ago. It is very difficult to determine with minute accuracy the actual frictional resistance of the surface of a large vessel; the workmanship, condition of plating, and other minor factors affect it appreciably, and marine growth may increase friction radically. Experiments in the United States Model Basin, with plates exposed to fouling, near Norfolk, Va., indicated that in seven months, from July to February, a marine growth by no means excessive, consisting mostly of barnacles, averaging in total weight when dry one quarter of a pound per square foot, would increase the frictional resistance by as much as 210 per cent. Moderate ordinary corrosion with no appreciable fouling will also materially increase frictional resistance.

In connection with the friction of models, it may be of interest to record that the experience of the United States Model Basin, as regards variation of friction with temperature, does not appear to be in accord with the rather discordant results obtained in Great Britain. In the early days of the establishment, in 1899-1900, Froude's frictional coefficients, deduced from experiments with varnished wooden planes, were carefully checked as regards planes 20 feet long and 18 inches wide (6.1 meters by 0.457 meter). These also were varnished wooden planes, and the results were in substantial agreement with those of Froude. During the last few years, information has been published as regards the variation of resistance of models with variation of temperature in the model tank for the tank of the Messrs. Denny, at Dumbarton, Scotland, and for the William Froude tank at Kew, England. Sir Archibald Denny[3] stated that "the correction should be 4 per cent for 10 deg. F." In the same discussion, Mr. Baker[4] stated, "With regard to skin friction correction, Sir Archibald Denny takes 4 per cent correction on the whole for a 10-degree change in temperature. We ourselves correct 3 per cent for the same range of temperature, but we only take our correction on the skin friction, because, so far as I can see, temperature cannot affect the wave resistance."

In 1912 a special investigation of this matter was undertaken at the United States Model Basin, it being planned to run a model of a battleship and a model of a torpedo boat destroyer monthly, and note temperature upon each occasion. The models used at the United States Model Basin are of wood, varnished, and before a run each model was smoothed by sandpapering and revarnished. The ordinary variation of temperature of the water in the United States Model Basin is from about 80 degrees in the height of summer to about 54 degrees in midwinter. The temperature would fall much lower in the winter, except for the fact that the building is thoroughly heated in cold weather. In the winter of 1913, after filling the basin with fresh, cold water, the trial models were run in water as cold as 44.5 degrees. The results of these experiments were quite consistent. The only anomaly developed was when, after nine months, there had been such an accumulation of varnish that the varnish was scraped off and the models revarnished. This resulted in an anomalous reduced resistance of 3 per cent. The results may be summarized as follows:

With change of water temperature there was a perceptible change in the resistance of both the battleship and destroyer models. These changes in resistance, due to temperature, were apparently more closely related to the frictional resistance than to the residuary resistance, and the percentages given below are based on the frictional resistance alone. For the battleship model, the decrease in resistance for 10 deg. F. increase in temperature was about 1.9 per cent of the frictional resistance, and for the destroyer model 2.3 per cent of the frictional resistance.

It is seen that this variation is much less than that apparently occurring in Great Britain. The difference may be due to one or a number of different causes. The models used in the United States Model Basin are 20 feet (6.1 meters) instead of 12 feet to 14 feet (3.66 to 4.27 meters) as usual in the British tanks; the models are wood, varnished, instead of paraffine; the average temperature in the Washington tank is materially higher than that of the British tanks; the water used, which is taken from the Washington city mains and has passed through sand filters, may be different in quality. Although the water used in filling the tank at intervals of from a few months to several years is taken direct from the Washington city mains, the small stream kept constantly running in is refiltered with a small amount of alum injected prior to refiltering.

It has been the endeavor of many people in the past to devise a formula expressing the resistance of a ship. The numerous results of the model-basin experiments which have been published in the last ten or fifteen years have been rather discouraging to the development of any such formula.

We have learned that a factor which is of importance at one speed is almost negligible at another. If we take two vessels, identical in dimensions and displacement, and build one with fine ends and the other with full ends, the fine-ended vessel will offer much less resistance over a certain range of speed, while at extreme speeds the full-ended vessel will be materially better.

Some years ago there were published the results of experiments with a large number of models at the United States Model Basin,[5] where proportions and coefficients had been varied systematically. The general results of this so-called standard series agree very

* From a paper presented at the International Engineering Congress, San Francisco, Cal.

[1] Chief Constructor, United States Navy.

[2] "Harmonie der Schiffsformen," by M. H. Bauer, in the "Jahrbuch der Schiffbautechnischen Gesellschaft," 1914.

[3] Page 63, *Transactions* of the Institution of Naval Architects, 1914.

[4] Page 64, *Transactions* of the Institution of Naval Architects, 1914.

closely with the general results from a very large number of additional models of usual types tried at the United States Model Basin, and also agree very well with exceptional results from other model basins. If a formula or formulæ could be devised which would accurately express the plotted results of the standard series referred to, we should have the desideratum of many years. Attempts to do this have not been very successful, but the results, as plotted, show the broad features of the resistance of ships of usual types.

In the first place, the actual size of a vessel, its displacement, is, of course, the primary factor in its resistance. In the second place, the proportions come into play. Viewing this aspect of the case, the most important feature is the length used for a given displacement. Beam and draft are comparatively minor factors, while the length is a major factor. Length is of peculiar value for cutting down the wave-making resistance; hence, we find that for fast vessels, where wave-making resistance is of such importance, the total resistance may nearly always be decreased by increasing the length. The third factor of primary importance is the longitudinal or prismatic coefficient, or what is in a way the same thing, the nature of the ends, whether fine or full. This is a very important factor. For speeds which are moderate in proportion to the length of the vessel—that is, when the speed-length ratio, or speed of vessel in knots divided by the square root of the length in feet is below about 0.8 (0.442 in metric units)—the large midship section and fine ends are nearly always favorable to speed. About a speed-length ratio of 0.95 (0.525), there is a somewhat indeterminate region where variation of the longitudinal coefficient does not produce much effect. For high speeds, however, say of speed-length ratio above 1.25 (0.695), we gain, by reducing the midship section and using large longitudinal coefficients, even up to 66 per cent.

There appears no question that the fore body has much greater influence upon resistance than the after body. Experiments, described in the *Transactions* of the Society of Naval Architects,[6] show that radical variations in the shape of sections of the after body produced comparatively little effect upon resistance. The shape of the sections forward, however, does materially affect the resistance, and for the great majority of vessels there is no doubt that fine or hollow lines forward near the surface of the water, resulting in forward sections full below water, even bottle-shaped in many cases, are favorable to speed. Many seagoing people and naval architects are opposed to hollow water lines forward, but there are indications that the results of model-tank experiments are making more and more impression upon practical people; and although we may not again find in fashion the very hollow lines of Scott Russell, we are certainly much nearer to this extreme than we were ten years ago.

Sir Archibald Denny, in his presidential address this year at the Institute of Marine Engineers, pointed out that of late years there has been a decided reduction in the block coefficients of low-speed cargo vessels, due to unsatisfactory experience at sea with those of coefficients of 0.80 or over. It would not have been necessary to settle this question by trial and error on full-sized ships at sea, if careful investigations of models had been carried out. There have now been published sufficient results of systematic model investigations[7] to enable the competent naval architect, dealing with merchant vessels, to settle with quite satisfactory accuracy the relative financial results to be expected in service from vessels of varying form and fullness of unusual types. For special and unusual types and for vessels for high speed in shoal water, it is necessary to go largely by guesswork or to have recourse to model experiments, which will be found, by far, the most profitable capital investment in such cases.

A New Antiseptic

SOME notes on a new antiseptic were contained in a recent issue of the *British Medical Journal* that has been named Chloramine. It is most conveniently produced by adding sodium hypochlorite to toluene sulphonamide, and is a colorless, crystalline substance, which, in the solid form, is quite stable. When dissolved in water it can be kept unchanged for several months. It is without corrosive action, is non-toxic and does not coagulate protein. Its germicidal action is, molecule for molecule, about four times that of sodium hypochlorite, and it is less irritating, and it can be used in concentration five or ten times as great.

[5] "The Speed and Power of Ships," D. W. Taylor, 1910.

[6] "Some Experiments with Models Having Radical Variations of After Sections," D. W. Taylor, *Transactions* of Society of Naval Architects and Marine Engineers, 1914.

[7] "Some Results of Model Experiments," R. E. Froude, *Transactions* of the Institution of Naval Architects, 1904. "The Speed and Power of Ships," by D. W. Taylor, 1910. "Model Experiments on the Resistance of Mercantile Ship's Forms," G. S. Baker, *Transactions* of the Institution of Naval Architects, 1914.

Quality of Limestone for Burning

The quality of limestone suitable for burning may vary, both chemically and physically, within rather wide limits. Chemical analyses of some samples of stone used for manufacture of lime are given in the accompanying table. They were made under the direction of Mr. P. H. Bates, chemist, by Mr. A. J. Phillips, assistant chemist, of the Bureau of Standards of the Department of Commerce.

The chemical composition of a lime depends on that of the stone from which it was made. Consequently only those limestones may be used from which a marketable lime can be produced. It must be remembered that on account of the loss of about half the weight of the stone as carbon dioxide during the burning the proportion of every other constituent of the stone will be nearly doubled in the lime. The composition which a lime should have for any given purpose is a much-mooted question and will be fully discussed in the following chapter on the uses of lime.

For the present it may be stated that the presence of a rather large proportion of impurities in the stone is permissible, except where a finishing lime or a particular grade of chemical lime is to be made. The ratio of calcium to magnesium desired depends largely on the market in the particular locality. When the lime is sold for chemical purposes, this ratio will generally be specified.

Chemical composition. The chemical composition of the stone influences the cost of burning. Experience has shown that it generally requires less heat and a lower temperature to burn a magnesian than a high-calcium stone. The greater the proportion of impurities, the more easily is the lime overburned, and therefore too large a proportion of these constituents will cause a diminution of the capacity of the kiln. It is possible that the proportion of silica may be high enough to form the dicalcium silicate ($2CaO.SiO_2$). This substance when cooled slowly assumes allotropic forms. Thus, at 675 deg. Cent. (1,247 deg. Fahr.) it charges from β to the γ modification, with a marked increase in colume.[1] This causes the lime to fall to pieces, a phenomenon commonly known as "fire slaking."

From the chemical analyses of the samples of stone collected it will be seen that the quantity of lime varies from 29.77 per cent to 55.56 per cent, and of magnesia from 0.31 per cent to 21.23 per cent, but that the total quantity of both carbonates combined in any stone is never much less than 97 per cent. The silica is occasionally somewhat over 2 per cent without injury to the stone for lime burning, but the alumina and oxide of iron are generally under 0.5 per cent. It must be remembered, however, that this investigation did not cover the entire field, and that limes are produced in which the proportion of impurities is so high that they are practically natural cements.

Physical properties. So far as its physical properties are concerned, any kind of limestone is suitable for burning. These properties do, however, influence the cost of production to a noticeable extent. Experience has shown that fine-grained, dense stone can be burned at a lower temperature and with less heat than one which is coarsely crystalline and porous. Coarsely crystalline stones, especially if very pure, are apt to fall to pieces in the kiln, thus reducing the production of lump lime. The same occurrence is sometimes noticed when a porous stone is used, although in this case it is probably due to the rapid expulsion of water from the pores. On the other hand, laboratory work done by the Bureau of Standards indicates that "all naturally porous stones lost their carbon dioxide at a lower temperature, 900 deg. Cent. (1,652 deg. Fahr.), than the denser materials." Why these laboratory results are contradicted in practice is a subject for future investigation, and is probably dependent upon the size of the pieces of stone, the quantity of material used, and similar factors.

Whether a limestone is porous or not, its water content is of importance, for this water must be evaporated, with the consequent loss of heat and lowering of kiln efficiency. Moreover, some of the water, in chemical composition with the clayey impurities of the stone, will probably not be given off until the stone has reached a red heat. This will require the stone to remain in the burning zone for a longer time and may therefore reduce the kiln capacity to some extent.

Evidently the first point to be considered in the manufacture of lime is the selection and opening of a suitable deposit of stone. The quality of stone required is noted above. It should be ascertained that the quality is reasonably uniform throughout the deposit and that a sufficient quantity of stone is above drainage level, so that the quarry floor will not be continually under water. Transportation facilities and other details of similar importance should be carefully considered.—*Mineral Resources of the U. S., 1913, Part II, U. S. Geological Survey.*

[1] Day, A. L. and Shepherd, E. S., The lime-silica series of minerals: Am. Chem. Soc. *Jour.*, p. 1089, 1906.

Ridding Houses of Insects

OCCASIONALLY in summer swarms of small insects will invade a community and infest houses in a most disagreeable manner. An ingenious method of clearing houses of such pests was devised last summer. Lighted lamps were placed in convenient locations, and as the insects gathered around the lights they were rapidly and effectually collected and disposed of by holding the nozzle of a vacuum cleaner near the lamp.

ANALYSES OF LIMESTONES.*a*

Company and location.	No.	Designation of stone.	Silica (SiO_2).	Alumina *a* (Al_2O_3).	Iron (Fe_2O_3).	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$)	Total.
Rockland-Rockport Lime Co., Rockland, Me.	1	Soft	1.29	0.15	0.35	95.91	2.27	99.97
	2	Rockport	2.41	0.22	0.40	85.18	11.72	99.93
Farnam-Cheshire Lime Co., Cheshire, Mass.	3	(*b*)	0.44	0.08	0.20	98.05	1.30	100.07
Connecticut Lime Co., Canaan, Conn.	4	(*b*)	0.34	0.19	0.28	58.20	41.16	100.17
New Jersey Lime Co., Hamburg, N. J.	5	McAfee	0.85	0.06	0.20	96.70	2.04	99.85
	6	Hamburg	1.21	0.41	0.45	95.70	2.25	100.02
Chas. Warner Co., Cedar Hollow, Pa.	7	West end south quarry	0.81	0.56	0.47	54.68	43.66	100.17
	8	East end south quarry	0.91	0.09	0.30	63.02	35.78	100.10
	9	North quarry *c*	2.27	0.51	0.40	53.16	43.89	100.23
	10	Whiteland	0.94	0.15	0.45	54.09	44.58	100.21
	11	White	0.53	0.04	0.05	99.21	0.74	100.57
Lowell M. Palmer Co., York, Pa.	12	Blue	0.14	0.02	0.10	98.73	1.01	100.00
American Lime & Stone Co., Bellefonte, Pa.	13	Calico	0.27	0.07	0.30	86.43	12.98	100.05
	14	Quarry No. 13	1.41	0.25	0.40	96.36	1.55	99.97
Thomasville Stone and Lime Co., Thomasville, Pa.	15	(*b*)	0.15	0.10	0.15	99.02	0.57	99.99
Riverton Lime Co., Riverton, Va.	16	Slaty	0.42	0.07	0.32	97.20	2.02	100.03
	17	Oily	0.36	0.07	0.22	96.07	3.26	99.98
	18	(*b*)	0.46	0.06	0.20	89.20	10.14	100.06
E. Dillon's Sons, Indiana Rock, Va.	19	Lower quarry	0.28	0.16	0.20	98.50	0.78	99.92
	20	Upper quarry	0.80	0.10	0.35	97.05	1.72	100.02
	21	Fertilizer *d*	1.05	0.40	0.55	96.21	1.76	99.97
Tennessee Marble Lime Co., Knoxville, Tenn.	22	Main quarry	0.16	0.13	0.06	98.93	0.76	100.04
	23	Other quarries	0.23	0.08	0.20	98.25	1.26	100.02
	24	Luttrell	0.65	0.05	0.30	84.50	14.53	100.03
Legarde Lime & Stone Co., Legarde, Ala.	25	(*b*)	1.64	0.33	0.31	94.39	3.42	100.09
Ash Grove White Lime & Portland Cement Co., Ash Grove, Mo.	26	(*b*)	0.10	....	0.05	99.05	0.88	100.08
Glencoe Lime & Cement Co., Glencoe, Mo.	27	Gray	0.32	0.13	0.30	98.29	1.05	100.09
	28	Blue	0.21	0.06	0.15	98.89	0.67	99.98
	29	Brown	0.26	0.02	0.20	98.84	0.65	99.97
	30	White *c*	1.35	0.53	0.40	94.89	3.05	100.22
Marblehead Lime Co., Marblehead, Ill.	31	(*b*)	0.21	0.04	0.10	98.45	1.28	100.08
Sheboygan Lime Works, Sheboygan, Wis.	32	(*b*)	0.55	0.24	0.40	55.09	43.91	100.19
Union Lime Co., High Cliff, Wis.	33	(*b*)	1.12	0.06	0.40	54.82	43.79	100.19
White Marble Lime Co., Manistique, Mich.	34	Manistique *c*	1.92	0.03	0.30	54.04	43.01	100.10
	35	Blaney	1.23	0.19	0.50	94.38	3.74	100.04
	36	Marblehead	0.56	0.05	0.20	55.00	44.31	100.12
	37	Indian Dam	1.04	0.05	0.25	54.25	44.52	100.51
Woodville White Lime Co., Woodville, Ohio	38	(*b*)	0.34	0.02	0.15	56.79	42.92	100.22

a For a more extended tabulation of analyses of limestones and limes, see Burchard, E. F., The production of lime in 1911: U. S. Geol. Survey Mineral Resources, 1911, pt. 2, pp. 658-707, 1912.
b Average of stone burned for lime.
c Not burned for lime.
d Burned for fertilizer only.

Coco palms and milo trees on an islet of the Hawaiian group.

These trees were probably both brought to Hawaii by the first Hawaiians, in the migration from the South Seas. Both are trees of economic importance—the palm for its nuts and the milo for its beautifully grained wood.—Photo by author.

The Woods of Hawaii

Notes on the Most Important Varieties, and Their Economic Value

By Vaughan McCaughey*

THE Hawaiian Islands have enjoyed political status as an annexed territory of the United States for a sufficiently long time to familiarize the continental public with the salient features of this lovely island-world. The volcanic origin of the islands, their Polynesian inhabitants, their discovery by Capt. Cook, their strategic situation from a military standpoint, the delightful climate, the highly organized sugar industry, and the beautiful forested mountains, are known in a general way to all educated people. The forests, because of their many peculiar and distinctive tree species, early attracted the attention of foreigners. Not until comparatively recently, however, has there been any thorough study of the economic aspects of the Hawaiian forests. It is the purpose of the present paper to briefly specify some of the economic values of Hawaiian timbers.

In the days of ancient Hawaii the forests were little disturbed by the natives. The settlements were almost exclusively along the seashore or in the valleys. The main uses that the natives had for timber were: logs, for the dug-out canoes, idols, and for certain household utensils, such as *kapa*-anvils and *poi*-boards; poles for the framework of the thatched houses; choice poles for spears and other weapons; select logs for wooden bowls and vessels; and limited quantities of fire-wood. Aside from the wood required for these few primitive needs, the forests were untouched. The early Hawaiians possessed no iron. They tediously felled and hewed the trees with a crude stone adz as their only edge tool. With such limitations the task of carving even a simple wooden bowl was exceedingly laborious. A year was required for the completion of an ordinary outrigger canoe. The lack of iron was a decidedly restraining influence in the utilization, by the ancient Hawaiians, of the hard, close-grained woods that predominate in all tropic forests.

Of the various woods that were used by the natives, the *koa* (*Acacia koa* Gray) undoubtedly stands first. The *koa* is the finest tree in Hawaii's forests, and forms extensive groves on all the large islands. It is peculiar to this archipelago, but is closely related to the Australian acacias. It attains a height of 50 to 60 feet, with stocky trunk and wide-spreading branches, which are large and contain much usable timber. The wood is typically rich golden brown in color, and varies through a series of tints, from a straight-grained, "piney," yellow, to a very handsome, curly grained, dark red. It is of medium texture, but takes a beautiful finish, and is prized for cabinet work, furniture, musical instruments, and for interior finishing. The natives formerly hewed their largest war-canoes from the *koa* trunks. Authentic records state that many of these canoes had seat spaces for one hundred warriors, sitting single file. The ravages of wild cattle and goats have seriously damaged—and in many places entirely destroyed—the *koa* groves, so that now there are few remains of the "big" *koa*.

The *ohia* (*Metrosideros polymorpha* Gaud.), is much more abundant than the *koa* and now outrivals it in commercial value. The straight-trunked, high-crowned tree reaches a height of over 100 feet. The wood is strong, tough, fine grained, dark red, and very durable. There are large forests of *ohia* on Hawaii, and these are being lumbered by local companies. The wood has come into prominence for flooring, paving blocks, railroad ties, bridge timbers, and other uses in which durability is of especial importance. In its structural qualities *ohia* rivals the best oak, although it cannot be obtained in as large sizes, for the *ohia* trunk is relatively slender.

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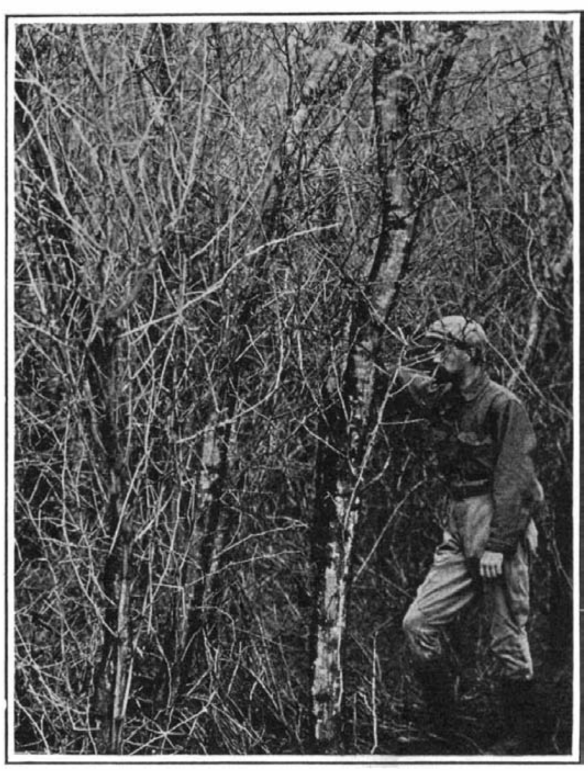


A Hawaiian "thorn-forest," composed chiefly of mesquite (Prosopis).

This tree bears large quantities of nutritious pods, which are highly relished by livestock. The thorny branches in this forest—which occupies many square miles of lowlands—makes a well-nigh impenetrable jungle.—Photo by author.

The sandalwood (*Santalum Freycinetianum* Gaud.) is a name to conjure with in Hawaii. In old monarchcial days the sandalwood forests were the treasury-houses of the kings. Sandalwood was ready money, and was recklessly squandered, so that now there is very little sandalwood of commerical size. In some parts of the islands, the small trees are plentiful, and are protected. The false sandalwood (*Myoporum Sandwicense*, DC., Gray) is abundant, and grows from sea-level up to 10,000 feet elevation. Upon the exhaustion of the sandalwood the Myoporum was used for a time as a substitute.

The Hawaiian ebony (*Maba Sandwicensis* A DC.; native name *lama*) is a common tree on all the islands and in some places forms pure stands. The tree is 25 to 35 feet in height, with very fine-grained, hard, tough wood, of a deep reddish-brown color. The Hawaiians formerly used this wood in connection with their temples and sacred enclosures; a section of Honolulu is to-day known by the ancient name *Ka Palama*—the place enclosed by the *lama*.

The most conspicuous and abundant tree in the lower forests is the *kukui* (*Aleurites moluccana*, L, Willd), but the wood is weak, coarse grained, not durable, and of no commercial value. The *mamani* (*Sophora chrysophylla* Seem) is the distinctive tree of the upper limits of the forest, 8,000 to 10,000 feet. Its hard, durable wood has brought it into general use for fence posts, sills, house timbers, and similar purposes.

There are several hundred arborescent species in the Hawaiian forests, but the great majority of these are small and their woods are of no commercial value. The prime economic significance of the forest as a whole is not as a source of timber, but as a watershed. Agriculture in Hawaii, despite the tropical environment, is very largely dependent upon irrigation water. Both the mountain streams and the artesian wells owe their water supply to the forested mountains. Hawaii's forest policy is justly famed for the rigidity of its conservation principles and regulations. The woods of Hawaii will never bulk in the world's timber trade, but the radiant beauty of the lovely forest mantle will long give these tropic isles their first and distinctive charm.

Wells More Than a Mile Deep

ACCORDING to the *Journal of Geography*, the deepest well in the world is in South Africa, over 8,000 feet deep; another deep well is in Upper Silesia, in the German Empire, 7,350 feet deep. A well in the United States which may go deeper, according to the United States Geological Survey, is about fifteen miles west of Pittsburgh. This well was 7,174 feet deep in June. Some gas and oil were struck in the upper part of the well. Between the depths of 6,830 and 7,100 feet, rocks bearing rock salt and salt water were encountered. The temperature in this well at the depths of 6,775 feet, as recently determined is 145.8 deg F.

At Derrick City, McKean County, Pa., near Bradford, there is a well 5,820 feet deep, which is probably the second deepest well in the United States. Another deep well is in Kanawha County, W. Va.; it is 5,595 feet deep. Deep-well drillers in this country, of course, employ the most improved and effective rigs, but one of the most remarkable of wells, reaching a depth of 3,600 feet, was drilled for petroleum in western China by means of such crude appliances as a cable made of twisted strands of rattan.

Protection Against Lightning

The United States Bureau of Standards has made an exhaustive investigation on the subject of protection against lightning, the results of which are published in an interesting report by Mr. O. S. Peters, Assistant Physicist of the Bureau, which appears as No. 56 of the *Technological Papers* of the Bureau. The report itself is too long for reproduction, but the conclusions reached are summarized as follows:

During each year there are approximately 1,500 persons affected by lightning stroke in the United States, about one third of this number being killed and the rest subjected to injuries which in many cases are permanent. Nine tenths of these accidents occur in rural districts.

Such evidence as is available on the effectiveness of lightning rods indicates that, taking rods as they come in the general run of installations, they reduce the fire hazard from lightning by 80 to 90 per cent in the case of houses, and by as much as 99 per cent in the case of barns. The same is undoubtedly true in the cases of other buildings having characteristics similar to those of barns and houses.

There is a more or less general opinion among persons who have given attention to the subject of protection against lightning that failures of lightning rods to give adequate protection are in many cases due to neglect to make extended metallic masses in proximity to the rods a part of the lightning-rod system. When these metallic masses are included in the system in the proper manner the danger of a flash leaving the rod and penetrating the building is much reduced.

The matter of the proper metal for lightning conductors has been much discussed, especially with respect to resistivity; but, inasmuch as the resistance of the metallic portion of a lightning-rod system is in most cases small in comparison with the resistance of the earth connection, the resistivity of the metal used is not of paramount importance; at least the differences of resistivity in the metals commercially available for lightning rods are not great enough to make one metal preferable over another.

There are two systems of protection in successful use, i. e., the contour system and the point system. Both systems present certain advantages, but it seems that the advantages obtained in the use of points outweigh the advantages of the other system. The chief difficulty present in the point system, which is not met in the contour system, is the mechanical one of keeping aerial terminals upright.

Insulators in clamps fastening lightning rods to buildings are no longer used except in localities where prejudice in their favor still demands that their use be continued.

The maximum current of a lightning flash may be more than 20,000 amperes.

A flash of lightning consists in most cases of a number of consecutive discharges of varying character which follow each other along the same path with very short-time intervals between them. The duration of a complete flash may vary in different cases from a very few thousandths of a second to half a second or more. The intervals of time between consecutive discharges in the same flash may vary from a few thousandths to one or two tenths of a second. The duration of each of the consecutive discharges of a flash is probably not more than two or three hundred thousandths of a second in most cases.

The rate of variation of current at any point of the path of each of the consecutive discharges of a flash of lightning is probably in most cases such as to make its effect similar to those of currents of frequencies of the order of several hundred thousand cycles per second, with the wave train so rapidly damped as to make it practically a unidirectional discharge. The magnetic effects observed in many instances point to either a unidirectional discharge or rapid damping. In fact, there seems to be no good reason for believing that a lightning discharge is oscillatory, although secondary effects from lightning discharges in neighboring conductors may be of an oscillatory character.

The path of a flash of lightning may be shifted by the wind while the flash is taking place, such shifting having been observed photographically to have taken place to the extent of at least 11.1 meters (36.4 feet).

The heating effects of a lightning stroke on a rod of ordinary size, i. e., a rod weighing 0.5 kilogramme per meter (5½ ounces per foot) or more, is not likely to be appreciable except at the place where the stroke enters the rod. It may also be appreciable at high-resistance joints.

The instantaneous potentials which may be set up between rod and earth by a flash of lightning because of the resistance of the earth connection may easily reach half a million volts or more with earth connections of the resistance of those ordinarily met within practice.

No system of protection for oil tanks has been devised which is accepted by oil companies as giving a degree of protection which is at all commensurate with the cost. It may be well to add in this connection that the systems of protection for powder magazines at present in use are not considered satisfactory; at least this is the impression to be gathered from published information. Much experimental work has been done, but the difficulty of preventing explosions seems to be almost insurmountable.

In the event of equal and large numbers of unprotected barns and houses being struck by lightning, about four times as many barns as houses would be fired.

There are no data to show that different objects equally exposed to lightning as to height, configuration, and other characteristics are not equally liable to be struck. From theoretical considerations it would appear that highly conducting bodies are more likely to be struck than insulating bodies; but there are no data available to show to what extent this is the case. The impression that some objects are more liable to lightning stroke than others undoubtedly arises from the fact that some are more susceptible to damage by lightning than others.

Such statistics as are available seem to show that when a stroke of lightning falls upon an unprotected house sheltering a family of an average number of persons, the chances are about even that one or more of the members will be injured or killed; but because of the fact that cases of lightning stroke on houses in which no severe damage to the building nor injury to persons occurs are very unlikely to be reported, it is quite likely that the chances are much less than even.

The metals commercially available as materials for lightning rods and which meet all of the other requirements in greater or less degree are copper, aluminium, and iron.

The most important property which must be possessed by the metal of which a lightning rod is made is resistance to atmospheric and soil corrosion. To impart this property to iron it must be galvanized.

Good mechanical construction is quite essential to permanency in a lightning-rod system, but at the present time it is not as a rule being given the attention it should have. The impression that a defective rod is necessarily a menace, however, is false; even a defective rod is generally better than no rod at all.

In constructing a lightning rod, contact between metals which occupy different positions in the electromotive series should, in general, be avoided. An exception to this is contact between copper and lead.

Corrosion of copper rods by smoke and gases can be effectively prevented in most cases by covering the rod with lead.

The rods sold at the present time which seem preferable are star-section iron rod and tightly twisted copper cable. Copper cable is sold woven in tubular form, but weaving copper cable in this form does not materially decrease the high-frequency resistance over that of a tightly twisted cable of the same number and size of wires. It does cause a slight decrease in self-inductance, but in a lightning-rod system a decrease of inductance can be better accomplished by offering the flash a greater number of widely separated parallel paths to earth than is usually the case.

The most economical and satisfactory earth connections are made with cast-iron or copper rods extending into the earth to a depth of from 6 to 10 feet, or to a point well below the foundation walls of the building to be protected.

The resistance of the earth connection should be made as low as practicable, in most cases it being impossible to get too low a resistance. A resistance which rises much above 15 or 20 ohms at any time should be considered as excessively large.

Aerial terminals with points should be located at all chimneys, gables, points, or other projections toward which a stroke of lightning might be directed. This is because a point can not be relied upon to protect objects other than the one upon which it is placed.

Down conductors should be run in such a way that a stroke on any aerial terminal on a structure will have two or more widely separated paths from the foot of the aerial terminal to earth. One path from an aerial terminal to earth has been found unsafe and more than two is preferable.

The return on an investment in lightning rods may be expected in two ways: In a sense of personal security from lightning and in actual security to both life and property. The property loss by lightning is not sufficient to cause protection against lightning always to be a paying investment. Protection against lightning is justified as an investment only where risk to human life is involved and where the property risk is high enough to make protection against lightning cheaper than insurance.

The loss of live stock in fields can be reduced by earthing wire fences by means of galvanized-iron pipe or posts at intervals of 100 yards or so, and breaking up the electrical continuity of the fence at intervals by inserting sections of non-conducting wood in place of the wire.

No place to which a person may ordinarily retire can be considered absolutely safe from lightning. The place of greatest safety which is ordinarily accessible is a well-rodded building; the next safest is undoubtedly an unprotected house, which may be regarded as much safer than in the open or in small unprotected buildings.

These forests are of value as water-sheds, rather than for their woods.—Photo by author.

Typical scene across the heavily forested valleys and ridges of an Hawaiian island.

Wood for Golf Clubs

Not being enthusiastic golfers, we have never paid much attention to the material of which golf clubs are made, but possibly some of our readers have attained that enviable position where golf may be played without neglecting other really important matters, and these may be interested in knowing that the wood of the crab tree was once regarded as the only wood worth considering for the heads of golf clubs. When the supply of crab tree wood ran short, beech was used for a time, but was ultimately given up for persimmon. It is said that this latter wood is now used almost exclusively for this purpose. Sir Herbert Maxwell, writing in *Kew Bulletin* now suggests a substitute for persimmon in the wood of *Cotoneaster frigida* and other species of *Cotoneaster*. These plants are members of the rose family and therefore closely related to the crab tree from which the original clubs were made. In the Old World, walking sticks, alpenstocks, agricultural implements, staves, and bows are made from this wood. The trees which produce it are abundant in Asia, especially in the Himalayan region.—*The American Botanist.*

The Structure of the Earth—II*

And Some of the Forces That Have Shaped Its Surface

By Prof. Grenville A. J. Cole, F.G.S., M.R.I.A.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2097, Page 163, March 11, 1916

ABRUPTNESS OF CERTAIN GEOGRAPHICAL CHANGES—RIVER CAPTURE

There is a totally different class of terrestrial phenomena which lends itself also to speculation, or to that imaginative faculty, proper to our Section, which enables the geologist to reconstruct. Geographers have taught us to speak lightly of river-diversion and river-capture, and to treat them as frequent occurrences in the history of existing lands. It is interesting to inquire what this process on a large scale may involve.

The draining of the Ragunda Lake in Sweden[20] in 1796, by the rapid cutting of a ravine 100 feet deep in a soft barrier, shows how many of our Glacial lakes, dammed by morainic matter, may have excavated their outlet gorges and run dry in the course of a few hours. The history of the temporary lake behind the Gohna landslip, so brilli ntly studied by our vice-president, Sir Thomas Holland,[21] provided a lesson both in hill-destruction and catastrophic flooding. The diversion of the Colorado River, however, in 1905, into the sluice leading to the Salton Sink gives us a definite illustration of river-capture. The "New River" thus produced in the depression to the northwest of Calexico cut a valley 70 feet deep through the agricultural land that it was meant to serve, and worked the head of this valley backward at the rate of a third of a mile a day.

One of the most remarkable instances of river-diversion in the European record is that of the waters from the north side of the central Alps. At the close of the Pliocene period, the north slopes of the St. Gothard mass and the Bernese Alps, supplying the torrents of the Reuss-Aar-Saane system, drained across the hummocky land near Bâle and sent their waters over to the Doubs. The great Rhine-trough drained southward, and its streams formed tributaries of the Alpine flow near Bâle. The Mainz basin, however, which was infilled by Lower Pliocene alluvium, became tapped by the head of a river that had long run northward from the Hunsrück-Taunus range. This river is the Rhine that we know north of Coblenz, and its alluvium was then spread out where the sea now stretches between Holland and the Yorkshire coast. Its mature valley is still traceable[22] above the present stream-cut in the hills. This river could have no direct influence on the course of the drainage from the Alps. But the bulging of the land at the north end of the Juras still continued. As the text-books remark with some complacency, the Burgundian gate was closed, and the river that had previously crossed westward was diverted northward to the Rhine-trough.

Can we exactly picture what this means? The whole Reuss-Aar-Saane system "on some particular day began to flow northward along the far older tectonic trough, carving away the infilling of detritus, washing back tree-stems that were floating quietly from the Lake of Mainz on their way to the Mediterranean, and finding, when it reached that lake, a notch sufficiently low for its escape across the Hunsrück-Taunus range. An enormous body of water was thus added to that which had formed in Pliocene times a mature valley across these hills."[23] The system indicated above, representing the flow from a hundred miles of snow-clad mountains, must have made a remarkable change in the stream across the Armorican hills. When the Alpine water arrived at the Mainz basin, and found its way into the notch formed by the Pliocene Rhine, it poured down upon the forest-covered delta-land. The changes that have occurred in the unconsolidated ground of Holland in historic times furnish some picture of what must have happened in the prehistoric delta of the Rhine. Land was suddenly built up at some points, islands were carved out at others, and the effects of the catastrophe must have been still manifest when the Scandinavian ice-sheet began to invade the mud-flats from the north.

THE CAPTURE OF THE VISTULA.

The capture of a large river may be illustrated by the story of the Vistula. This noble stream represents in a remarkable way the drainage of 190 miles of the Carpathians. All this water becomes concentrated, at the apex of a reversed river-fan, at the east end of the Kielce hills, and it is probable that the upper Vistula was driven to join the San by the advancing ice-front of the Riss age, and that both rivers then escaped southward. The joint waters were again held up when the Fennoscandian ice rested along the line marked by the Baltic Heights, and it is well known that a great river flowed westward along the stagnating ice-front where now the marshes of the Netze mark its course. As the ice-front shrank backward, toward the Baltic basin,[24] streams flowed down over the sands and boulder-clays and cut their valley-heads back southward. Overflows may have taken place on the unconsolidated wall of the great east-and-west river, which was now deprived of its barrier of moraine-filled ice. In one way or another, the shallow valley of the main river was tapped near Kustrin, and the Oder, rising in the Moravian plateau, was sent northward as an independent stream. Similarly, the Vistula was carried off at Fordon, where the bend due to capture is conspicuous at the present day; and the whole drainage of the north wall of the Carpathians swept across the drift deposits down the course of some hitherto unimportant stream. Along the valley thus carved out, brown and yellow cliffs now rise above the marshy flood-plain, and the red castles of advancing Germany have for centuries looked down firmly on the stream. It is quite contrary to our customary philosophy, but a good corrective all the same, to ask ourselves if this lower valley of the Vistula, eighty miles in length, was shaped in a few months or a few years. The main part of the excavation, across unconsolidated lands, may have occupied less time than the building of the strongholds at the fords.

EUROPE A SETTLED CONTINENT.

In spite of the swamping of the Alkmaar country in 1825, in spite of the tragedy of Messina only seven short years ago, we feel that Europe is a settled continent, and we judge the past and future by the present superficial peace. We have applied the same thoughts to human movements, and the inconceivable has happened in our midst. We naturally find it difficult to carry our minds back to epochs when the earth-blocks may have parted asunder as ice parts across the polar seas. We have still, however, very much to learn about causes now in action; and the mystery of the earth, and of our connection with it, grows upon us as we learn. Can we, at all, realize the greatest change that ever came upon the globe, the moment when living matter appeared upon its surface, perhaps over a few square miles? Matter is either dead or living, that is, endowed with life; there is no intermediate state. And here was living matter, a product of the slime, if you will, but of a slime more glorious than the stars. Was this thing, life, a surface-concentration, a specialization, of something that had previously permeated all matter, but had remained powerless because it was infinitely diffuse? Here you will perceive that the mere geologist is very much beyond his depth. Let us return to our orderly studies, our patient hammerings, our rock-slices, our chiseling out of fossil shells. Behind it all is the earth itself, quiescent, it may be, but by no means in the sleep of death.

* Presidential address before the Geological Section of the British Association. Abridged by the author in *Nature*.

[20] See especially H. W. Ahlmann, "Ragundasjuns Geomorfologoi," *Sveriges Geol. Undersok*, 1915; also Ahlmann, Carlzon, and Sandegren, "Quaternary History of the Ragunda Region, Jämtland," *Geol. Fören. Förhandl.*, vol. xxxiv. (1912), p. 343.

[21] Records, *Geol. Surv. India*, vol. xxvii. (1894), p. 55, and *Nature*, vol. i., p. 501.

[22] W. M. Davis, "Die erklärende Beschreibung der Landformen" (1912), p. 106.

[23] G. A. J. Cole, "The Growth of Europe" (1914), p. 109.

[24] R. Lepsius (*Geologie von Deutschland*, pt. 2, p. 511) urges that the sinking of the floor of northern Europe led to this northward trend of the streams.

The Proper Mixing of Chemical Solutions Used in Photography

THE importance of seeing that solutions are properly mixed before they are used for the purpose for which they are intended has received very little attention on the part of photographers generally, although many defects in negatives and prints might be traced to neglect of proper precautions to insure it. In the case of developers, a common practice is to add two stock solutions together in suitable proportions, and then make up to the desired quantity by the addition of water, with perhaps, "if considered necessary," a little potassium bromide as well. The developer is then considered as mixed and ready for use, although, as a matter of fact, the constituents are not at all intimately mixed; and if a solution of this kind is poured over an exposed plate some portions of the image will develop unevenly, although this unevenness may not be apparent in an ordinary negative, because of the general details hiding the defect; but in a negative from an object having a large surface of uniform tint in it the defect is at once noticeable, the developed plate showing the inequalities quite readily. The same thing is often encountered when developing bromide and other papers, especially when the paper is wetted before applying the developer. Some workers, with a view to insure, as they suppose, a perfect mixing of the developer, pour it from the measure into the dish, and back again; and although this method does help the mixing, at the same time it tends to accelerate the oxidation of the developing solution, and in many cases leads to the formation of air-bells and spots in the negative. As a rule, a better plan to adopt is gently to stir the mixture with a glass rod. If we carefully consider the subject, we arrive at the conclusion that the mixing process must disperse the various ingredients throughout the whole volume of the solution; and, if time is not allowed for this diffusion, the solution will be streaky and not uniform. If alcohol, which is specifically lighter than water, be poured upon the latter, the liquids will gradually intermix; in spite of the difference of their specific gravities, they will diffuse into one another. As the results of investigations, the laws relating to diffusion, "when no porous diaphragm is used," are generally stated thus: First, when solutions of the same substance, but of different strengths, are mixed, the quantities diffused in equal times are proportional to the strengths of the solutions; second, in solutions which contain equal weights of different substances the quantities diffused will vary with the nature of the substances; third, the quantity diffused also varies with the temperature. Considering all the facts, the only way that the photographer can safely insure the perfect mixing of his developing "or other" solutions is by the use of a proper mixing measure. This takes the form of a tall cylindrical measure, fitted with a stopper, preferably graduated, and holding just the quantity of solution required for use. Perfect mixing may then be brought about by reversing the measure several times, when on account of the measure not being quite full a large air-bubble would be formed; and this traveling up and down the flask would bring about a more perfect mixing than would be possible in any other way. This method of mixing solutions by means of a big air-bubble passing up and down a tubular measure is well known to chemists, and such measures, graduated either in cubic centimeters or in ounces, can be obtained from dealers in chemical apparatus fairly cheaply. A further advantage of these stoppered measures lies in the fact that solutions will keep in them as well as in stoppered bottles; and it is always best to allow the solution to stand for a few minutes after mixing in order for diffusion to bring about a perfect admixture. All these precautions in the mixing of solutions may appear to most workers as quite unnecessary; but when we remember that a small quantity of potassium bromide is often added last to a developer, and that this has to become diffused throughout the entire volume of solution, the time necessary may be a fairly long one, unless some means be taken to aid proper mixing.—Edgar Senior in *Knowledge*.

Testing Hardness of Metal

SEVERAL devices for testing the hardness of metals have been devised, but as they are more or less elaborate in their construction they are not portable, and moreover, on account of their size they cannot be used in all situations. In the *Revue de Metallurgie* is a description of a very simple and compact device that is quite compact and so portable that it can be used almost anywhere. It employs a steel ball protruding from the end of a hollow mandrel backed by a cylindrical slug of known hardness on the Brinell scale. A plunger, protruding from the opposite end, surmounts this slug. When in use the ball is brought into contact with the piece to be tested and the free end of the plunger is struck with a hammer. A comparison is then made of the indentation with that of the standardized slug. The device is 30 millimeters in diameter and 90 long.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Gilmore's Restoration of Ceratosaurus Nasicornis

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In the issue of the SUPPLEMENT of the 15th of January last I published an article entitled "Monster Extinct Reptiles," illustrated by seven figures, six of which were devoted to some recent restorations of these remarkable forms which, as we know, died out a million or more years before man made his appearance upon this planet. The original models presenting these restorations were made by Mr. Charles W. Gilmore, curator of fossil birds and reptiles in the United States National Museum, and they are considered to be, by palæontologists who have had the opportunity to study them, among the best pieces of work of the kind that have thus far been offered to science—in the matter of technique as well as in their probable correctness.

Both Mr. Gilmore's work and my article have attracted no little attention, not only in the United States, but abroad as well, especially in France and England. Among the letters received on this subject there comes one to the Editor of the SUPPLEMENT from the distinguished British sculptor, Walter Winans, dated at London the 3rd of February, 1916. In this communication Mr. Winans says: "In your SUPPLEMENT of January 15th, 1916, you give drawings of restorations by Dr. R. W. Shufeldt of 'Monster Extinct Reptiles.' Now, it is very presumptuous of me to criticise these, but I am a sculptor, and it has always struck me that all models of restorations of these animals are put wrong on their legs.

"Speaking as a sculptor, all these restorations show very heavy bodies standing even more upright on their legs than a horse, although their legs are very feeble and body very heavy.

"I do not think an animal could support itself upright on such legs. These animals must have rested on their bellies on the ground like all saurians, [as in the case of] alligators and crocodiles, and only used their legs for crawling about on when on dry land, and as oars when swimming.

"I enclose a rough sketch of what I mean.

"Speaking as a sculptor and artist, it seems to me my sketch is more natural than Dr. Shufeldt's model of the same reptile.

"I know nothing of the anatomy of reptiles, and only put out this hint as perhaps worth taking note of.

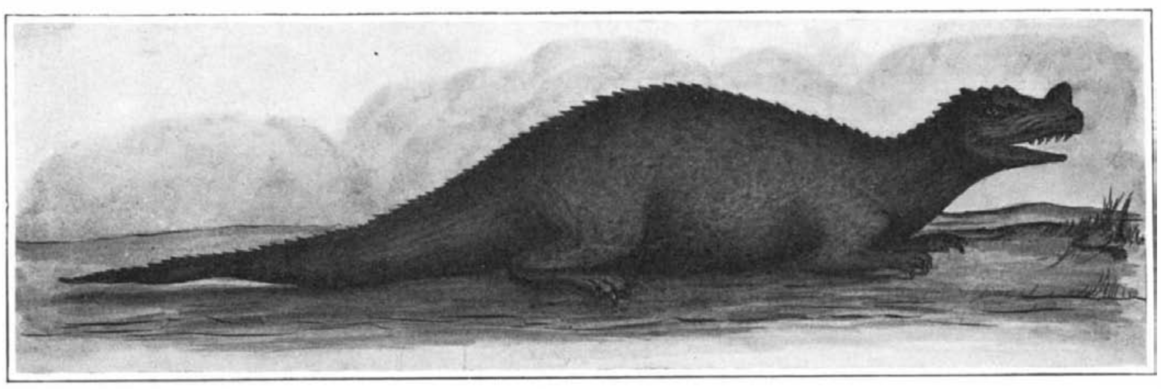
"Yours very truly,

[Signed] "WALTER WINANS."

This letter and sketch having been referred to me for reply, I would first say that the sketch submitted by Mr. Winans, although a clever outline, such as one would make to illustrate remarks in a letter, is not suitable as an illustration in such a magazine as the SCIENTIFIC AMERICAN SUPPLEMENT. I therefore have taken the liberty of making an absolutely correct tracing of this sketch, filling it in as a wash drawing, and I submit it here as a figure to illustrate Mr. Winans' idea as to the probable form and customary pose or carriage of *Ceratosaurus nasicornis* in life. This extinct reptile is Fig. 5 of my above cited paper, which figure gives Mr. Gilmore's restoration, and not one of mine, as Mr. Winans inadvertently states in his letter.

From the viewpoint of a palæozoologist, I may say that, while the question Mr. Winans raises is one of great interest, he is quite in error in nearly every point in the argument he puts forth. In the first place, he seems to think that, in the case of *Ceratosaurus nasicornis*, the legs were not sufficiently strong to support the animal in the bipedal attitude. Such a statement contradicts not only what the skeleton of this reptile plainly indicates, but also the entire history science has accumulated from all parts of the world on the probable habits of these animals. If Mr. Winans will more carefully study Fig. 5 of my article, he will note the great discrepancy in the size and probable strength of the fore and hind limbs of *Ceratosaurus*, and that the hind pair, when covered with the muscles that belong there, are more than capable of supporting the weight of such a creature, and of endowing it in life with exceptional power in the matter of rapid locomotion.

Mr. Winans seems to be under the impression that all reptiles, both living and extinct, get about on all four limbs like a hippopotamus, while we have still living such animals as the kangaroos, which get over the ground much as *Ceratosaurus* did when living. Moreover, Mr. Winans has entirely overlooked the fact that we have still in existence *saurians* that possess locomotory powers and action almost identical with what was the case in these particulars with the extinct *Ceratosaurus*. To study these I refer Mr. Winans to that interesting group of lizards occurring in the existing reptilian fauna of Queensland, Australia, which has been so carefully described and figured for us by Mr. W. Saville-Kent in "The Living Animals of the World" (pp. 566-568). These medium-sized saurians run with marvelous rapidity, and in doing so employ only their *hind limbs*. In his account of them Mr. Saville-Kent says: "The several instances of bipedal locomotion among living lizards, as here chronicled, are of especial interest in correlation with the circumstance that certain extinct dinosaurs habitually progressed on their hind limbs only. They, in fact, have left 'footprints on the sands of time.'" (p. 568.) This is common knowledge among zoologists all over the world at the present time, and to extend that knowledge will be one of the important objects in replying to Mr. Winans' letter.



Ceratosaurus nasicornis, as sketched by Mr. Winans.

As modern birds have, in time, ascended from reptilian stock, there were, without doubt, many semi-saurian forms along the ancestral line that possessed bipedal locomotion. Some of these were true reptiles, but there were doubtless others that approached much nearer the avian stock—until at last we have, in modern birds, the true bipedal animal. The story reads like a veritable romance, and as it is recorded in the most recent and authoritative text-books on zoology and palæontology, I would respectfully refer Mr. Winans to these for information.

As the restoration of *Ceratosaurus nasicornis* under discussion is by Mr. Gilmore and not by me, it is no more than proper that he should have a word to say in this matter. With this in view I communicated with him, and promptly received the following information:

"MY DEAR DOCTOR SHUFELDT:

"Regarding the normal mode of progression of *Ceratosaurus*, I am of the opinion that if ever there was a dinosaur that walked in an upright bipedal manner, with its body free from the ground, this one did. In the first place, the flesh-eating habits of *Ceratosaurus* would necessarily require rapidity of movement, in order to capture sufficient prey to sustain life; secondly, that it was not quadrupedal in gait is abundantly indicated by the very short fore legs as compared with the hind; especially significant are the digits armed with long, curved claws, well adapted for use as seizing, holding and tearing appendages, but wholly unsuited for walking purposes.

"Furthermore, the limb bones are finely modeled, of dense texture, and with narrow cavities in all of the long bones; in fact, all parts of the skeleton are thus lightened by cavities within the bone—a mechanical adaptation giving the greatest strength with the minimum of weight, just such a structure as would be required in an animal of great strength and agility.

"The most convincing evidence as to the gait of this type of animal is found in the fossil footprints of these huge, three-toed carnivores, which occur so abundantly in the Triassic rocks in certain localities in Massachusetts and Connecticut. These tracks were made by the progenitors of *Ceratosaurus*, which they closely resemble in the general form of their skeletal structures. Some of these trails have been traced for considerable distances, and only the imprints of the large, three-toed hind feet are recorded, though some slabs show where the tail occasionally left its imprint, as it dragged here and there for short distances. Likewise, impressions of the fore feet are occasionally observed, where the animal temporarily balanced on them while at rest; but when the animal was walking, none of the smaller imprints are ever found.

"I have only briefly outlined some of the reasons for giving the model restoration of *Ceratosaurus* the pose I did, but this evidence is perhaps sufficient to show the absurdity of the argument for a crawling quadupedal gait for this animal.

"Very sincerely yours,

[Signed] "CHARLES W. GILMORE."

If your correspondent should desire to pursue this matter further, it will afford me pleasure to cite some of the literature upon this very extensive subject.

Washington, D. C. R. W. SHUFELDT, M.D.

Gasoline from Natural Gas*

THE casing-head gasoline industry in the United States is a development of the decade ending with 1914. According to Burrell, Seibert and Oberfell,[1] gasoline was made from the gas of oil wells near Titusville, Pa., in the fall of 1904 by Andred Fasenmyer, whose output the first year aggregated 4,000 gallons, which was sold at the rate of 10 cents a gallon. Other plants were installed about the same time at Tidioute and Warren, Pa., but it was not until 1909 that the industry became important, and not until 1911 that the Geological Survey began compiling statistics of the annual gasoline output derived from natural gas.

The available statistics show a remarkable growth in the industry during the last four years. In 1911 the total number of plants in the entire United States for the manufacture of casing-head gasoline was only 176 and their total daily capacity was only 37,100 gallons of gasoline. In 1912 the total number of plants increased to 250, a gain of 42 per cent, and the total daily capacity increased to 61,268 gallons, a gain of 64 per cent. In 1913 the number of plants increased to 351, a gain of 40 per cent, and the daily capacity increased to 152,415 gallons, a gain of 150 per cent. In 1914 the number of plants increased to 386, a gain of 10 per cent, and the daily capacity increased to 179,353 gallons, a gain of 17 per cent.

The actual output of the plants in operation in 1911 amounted to 7,425,839 gallons; in 1912 this output was increased to 12,081,179 gallons, a gain of 63 per cent; in 1913 the output increased to 24,600,817 gallons, or a gain of 100 per cent; and in 1914 the output increased to a total of 42,652,632 gallons, a gain of 77 per cent over 1913. Roughly, then, the quantity of gasoline produced from casing-head gas in the year 1914 amounted to 853,053 barrels of 50 gallons each, and constituted a very substantial addition to the supply of motor fuel available in the United States. Should the present rate of gain in production be maintained during 1915, the output of gasoline extracted from casing-head gas will be in excess of 1,500,000 barrels.

When the fact is considered that the average price received for casing-head gasoline in 1914 was only 7.28 cents a gallon, compared wih 10.22 cents in 1913, the increase of 77 per cent in the quantity of gasoline produced is rather surprising. The reason for the depressed market in 1914 lies in the great increase in refinery stocks of gasoline derived from crude petroleum incident to a period of low prices for high-grade petroleum brought about by conditions of overproduction in the Cushing field, Oklahoma, and by a temporary curtailment of the export trade following the outbreak of the European war. The total value of the gasoline manufactured from casing-head gas in the United States in 1914 amounted to $3,105,909, an increase of $647,466, or a little more than 26 per cent over the total value of the production marketed in 1913.

The casing-head gasoline industry was limited to nine States in 1914, as follows, named in the order of their rank in quantity of marketed production: Oklahoma, West Virginia, California, Pennsylvania, Ohio, Illinois, Kansas, New York and Colorado, the only production in Kentucky coming from normal condensation in gas mains. West Virginia, which had led for the preceding three years, was superseded by Oklahoma in 1914, West Virginia taking second place, previously occupied by Pennsylvania, which in turn was relegated to fourth place by California, which advanced from fourth to third place. The principal gain in casing-head gasoline output in 1914 is credited to Oklahoma, which exceeded its output of 6,462,968 gallons in 1913 by 10,814,587 gallons, constituting a gain of 167 per cent.

* "Mineral Resources of the United States," 1914, Part II.

[1] Burrell, G. A., Seibert, F. M., and Oberfell, G. G., The condensation of gasoline from natural gas: U. S. Bur. Mines Bull. 88, 1915.

Meteorology of the Moon*

Various Phenomena from Which Lunar Conditions Are Deduced

By William H. Pickering†

The fundamental fact on which is based the study of the meteorology of Mars is the melting of its polar caps. The moon has no well defined polar caps, although its northern and southern limbs are appreciably brighter than either of its equatorial ones. There are, however, scattered over the whole of its surface numerous minute white spots more or less sharply defined and it is to some of these that we shall now direct our attention.

The object with which we will begin our studies is the well-known mountain Pico. This mountain is situated in longtitude 9 degrees, latitude +45 degrees. Its vernal equinox therefore occurs at colongitude 9 degrees, its summer solstice at 99 degrees, or just after full moon, and its autumnal equinox at 189 degrees. Its altitude is 8,000 feet or 2,500 meters, and its length east and west 10 seconds, 11 miles, or 18 kilometers. No craters whatever have been detected upon it, but if any existed that were less than 0.1 seconds, 500 feet or 150 meters in diameter they would probably have escaped notice. It is not strictly a mountain in the geological sense of the word, but rather a spiracle or pinnacle, such as occur in some of our volcanic regions, Mem. Amer. Acad., 13 Plates 19 and 20. Perhaps the best idea of its appearance as compared with terrestrial mountains may be obtained from Figure 7, see Plate VIII. The figures on this plate are all oriented with north at the top. This is unusual, but is much better adapted to the illustration of the present paper than the usual orientation would be.

It is perhaps unnecessary to state that every line and shading shown in the drawing actually exists on the moon. It has not been touched up in any way to give it a resemblance to a terrestrial peak, but the mountain is represented exactly as it appears as seen through the telescope. Independent drawings made a little earlier and later in the lunation show practically every detail shown in the present sketch. It was drawn just as the sun was setting upon it, and consequently its western side is invisible. It must be remembered that on the moon the terms east and west are given the reverse meaning that they have on the earth and Mars. What we call east on the planets is called west on the moon, and *vice versa*.

Although this view gives the effect of having been sketched from but a slight elevation above the plain on which the mountain is situated, yet the angular elevation of the line of sight, as is shown by the latitude above given, is 45 degrees. Pico is therefore not quite as steep as it appears in the sketch, the eastern slope lying at an angle of approximately 35 degrees, and the western, shown in Figure 1, of about 42 degrees. It is also noticeable that the snow is found on the ridges, and not in the ravines, as in the case of our own large accumulations of ice. This is even more conspicuous in the case of Teneriffe shortly before the time of full moon, where the ridges and ravines are much more marked than they are on Pico.

As to the origin of the formation, it is pretty clearly a piece of the original lunar crust which was surrounded but not overwhelmed by the great fissure eruption causing the Mare Imbrium. If of less specific gravity than the black lava of the eruption, it might even have floated away from its original location and possibly turned over like an iceberg. In such a case there would be no reason to expect to find craterlets on its present summits. Nevertheless, the fact that the snow is found mainly upon the ridges leads us to believe that cracks exist along their crest lines. From these cracks water vapor escapes, and on account of the deficiency of the lunar atmosphere is immediately redeposited as snow.

This peculiarity is shared by other lunar mountains as we have just seen, and would lead us therefore to believe that Pico still occupies its original position, and has withstood the devastating flood by which it was surrounded.

In the accompanying plates the first seven drawings represent Pico. Located upon the mountain are eight prominent white patches which we shall designate as snow. They have been lettered as indicated in the third figure. Although located in longitude 9 degrees, yet so high does it rise above the surrounding plain, that the sun first touches its summit shortly before colongitude 7 degrees. At 7.1 degrees not only is spot *a* located upon the very summit of the mountain, dazzlingly brilliant; but the more elevated portions *b* and *c* can also be seen. By 9 degrees *c* has rapidly increased in size, but *a* and *b* are practically unaltered.

At colongitude 19.6 degrees, Fig. 1, *c* has about double its size, and other portions of the mountain are now visible, together with its long shadow stretching away toward the east. Spot *a* is of brightness 10 and *b* and *c* 9, or a very little fainter.

By colongitude 32.9 degrees, Fig. 2, nearly the whole of the southeastern side of the mountain has become visible, but none of the snow patches located upon it in some of the later figures have yet formed. Directly below the eastern summit, however, a crescent shaped area has appeared which was described and painted as distinctly green, greener than the *mare*, which itself at this age of the moon is slightly greenish. Beneath the crescent a large area appears which is still in shadow, and close at hand to the west is another one, while spot *a* has increased in size, and the whole of it is now illuminated; spot *c* on the other hand has diminished, probably through melting. The next night at colongitude 44.0 degrees much trouble was experienced from passing clouds, but it was clear that *a* was unchanged, while *c* had increased in size, appearing as in Fig. 1. The whole of the southeastern face was still dark, with the exception of a small white spot which had appeared half way up the slope, at the top of what was later designated as *d*. An observation made on September 21st, 1912, at 40.7 degrees records that there was no snow at all at that time to be seen on the eastern face of Pico.

In Fig. 3, colongitude 55.9 degrees, the whole eastern face is resplendent with freshly formed snow, yet not quite so brilliant as at the higher levels, perhaps because on the lower and steeper slopes small projections of rock more frequently interrupt the bright surface. Spot *c* has greatly increased in size, *a* has diminished by melting away from the eastern end of the ridge, while new spots have formed at *d*, *d'*, *e*, *f*, and *g*. Spots *d*, *d'*, *e*, and the western ends of *b* and *c* were distinctly greenish, and this appearance frequently occurs when the formation of snow is very light, due perhaps to small scattered patches. The effect may be subjective, although it does not look as if it were. Spots *f* and *g* were the brightest of the southeastern patches, a supremacy which the southern one, *g*, soon loses under the influence of the direct summer sun.

The next night, 68.2 degrees, spot *a* had returned to the eastern end of the ridge, increasing slightly in size at the same time; *b* and *c* had diminished, the latter notably; indeed it varies more in size and shape than any other spot on the mountain. This is quite natural since it lies on a wide comparatively level region, with a southern exposure. In fact it had broken into several smaller pieces which are shown in the drawing made early and late in the evening. Spot *e* had increased in size but not in brightness. Spots *d* and *d'* had now united, but *d* was distinctly the brighter of the two.

An interesting phenomenon is exhibited at this colongitude, when spots *a* and *d* begin apparently to steam. In a few hours thick clouds of vapor are thrown off, especially from *d*, so that its outlines become very hazy, and quite different from its earlier and later appearance, and from the other spots about it. Its color becomes decidedly bluish, and the fog or mist in a thin transparent stream is swept off across the *mare* to the south, as indicated in Fig. 9. The action becomes less violent about colongitude 90 degrees, and by 95 degrees has ceased altogether, as a usual thing, although it was observed on one occasion at the base of *d* as a very faint haze as late as 115 degrees. All the spots have occasionally been recorded as slightly hazy at about this time, but none of the others are at all comparable in this respect to *d*. At colongitude 76.8 degrees the ridges of Teneriffe have been recorded as steaming from end to end. In the meantime neighboring bright spots were perfectly sharp and distinct. This steaming might be either a case of melting snow or of volcanic activity, the steam condensing into ice crystals and falling as snow. The writer rather favors the latter view, since the other spots do not exhibit it.

Knowing what to expect at this colongitude, *d* was carefully examined early in the evening at 68.8 degrees, and was recorded as "not notably hazy." At 70.0 degrees it was recorded "*d* and *d'* rather indistinct, *d* the most so, but not as hazy as they have been seen." At 70.1 degrees "*d* is now clearly hazy." The next night at 81.9 degrees "All spots are more or less hazy, but *dd'* especially so." Where the steam flows away at the base of the mountain across the *mare* it is extremely faint.

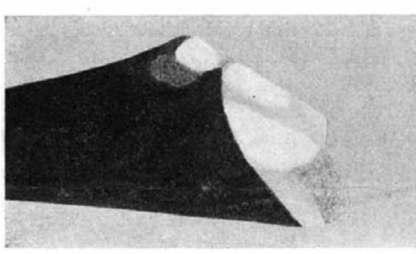


Fig. 1.

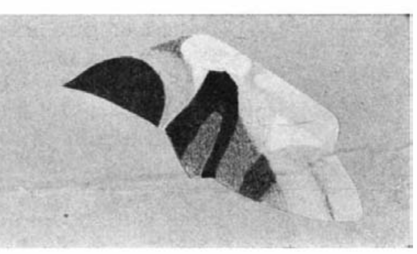


Fig. 2.

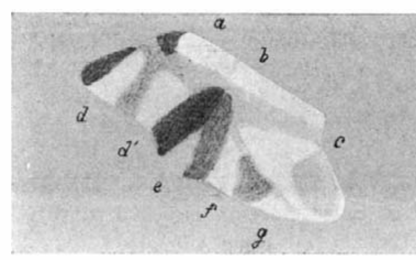


Fig. 3.

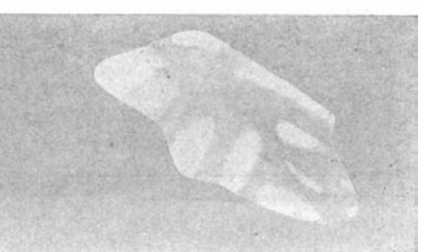


Fig. 4.

The following are all the other records that have been made pertaining to the haziness of *d*.

September 23rd, 1912. 64.8 degrees. No steam from Piton or Pico *B*, but Pico sending a thin streak south from *d*.

February 18th, 1913. 65.4 degrees. The "snow storm" has begun on *a* and *d*, but *d* is very faint, greenish, and quite separate from *d'*.

December 21st, 1912. 69.3 degrees. The snow storm has begun. *d*, *e*, *f*, and *g* are all hazy and bluish, but *d* much the most so, while *a*, *b*, and *c* are very sharp.

March 20th, 1913. 71.4 degrees. Pico *d* and *d'* enveloped in cloud.

August 25th, 1912. 72.0 degrees. Pico is perhaps beginning to steam.

November 22nd, 1912. 74.4 degrees. Pico. Snow storm on the northeast peak (*d*) well developed, bluer than the other peaks. The northern peak (*a*) shows the same to a less marked degree. 74.6 degrees. Snow storm wonderfully well developed.

September 24th, 1912. 78.5 degrees. Pico *d* is very foggy as compared to *b*, *c*, *e*, *f*, and *g*. Spot *a* is a little foggy, but nothing like so markedly so as *d*. The contrast between *d* and *f* especially is very striking.

December 22nd, 1912. 81.8 degrees. Pico. The snow storm on *d* still continues, but it is not so hazy tonight.

August 26th, 1912. 84.1 degrees. As compared with last night, 72.0 degrees, *d* has grown larger and more fuzzy.

March 21st, 1913. 84.4 degrees. Pico *d* is still a trifle brighter than *f*. It is a little more hazy.

January 21st, 1913. 86.0 degrees. Pico, storm at *a*, *b*, *c*, *d*, and *d'*.

September 25th, 1912. 90.4 degrees. All the spots except *c*, *e* and *f* are as hazy as *a*; *d* no more so than the others.

December 23rd, 1912. 94.3 degrees. Pico *d* is now much the brightest. The snow storm is over.

January 22nd, 1913. 97.8 degrees. Pico *a* and *d* have increased in size and are still a trifle hazy.

November 27th, 1912. 99.5 degrees. Pico *d*. Cannot be sure if the haziness has disappeared. 100.5 degrees. Think the snow storm still continues, but has diminished.

September 26th, 1912. 103.3 degrees. All the spots are sharp.

*Courtesy of *Popular Science*.

† Professor Pickering states that the illustrations are not entirely satisfactory, and that Figs. 1 to 8, inclusive, should show much more contrast, while Fig. 9 should show less, and should be practically identical in appearance with Fig. 4, as far as contrasts are concerned.

August 28th, 1912. 109.5 degrees. A very faint haze extending south from *d*.

November 25th, 1912. 113.2 degrees. The snow storm has ceased.

September 27th, 1912. 115.2 degrees. The base of *d* and *d'* is perhaps a little hazy, but all the rest of the mountains seem clear, including Pico *a*.

September 28th, 1912. 126.7 degrees. All the bright areas on all the mountains seem to be sharp.

The "snow storm" referred to in several of these extracts is a possible explanation of the phenomenon observed, since, as it progresses, *d* gradually becomes brighter than before and sometimes larger. At the same time *d* is clearly shown, with sharp borders, one day before the general haziness usually appears. Moreover some of the other spots, notably *f*, are equally bright with *d*, and only on the rarest occasions appear hazy.

In the fourth figure, 81.8 degrees, the notable changes from the previous one are the coalescing of spots *d* and *d'*, and the breaking up of *c* into small pieces. Spot *e* has broadened and grown brighter, gradually advancing towards the east. No marked change occurs for the next three days, save that the haze on the *mare* at the foot of *d* becomes more distinct. At the end of that time at colongitude 115.1 degrees spots *a*, *b*, and *c*, are found sometimes to have shifted their position angles so as to lie nearly northwest and southeast. Spot *a* does this by gradually working its way around the northern corner of the mountain. Spots *b* and *c* change more suddenly. On January 31st, 1915, at colongitude 106.7 degrees spot *b* had disappeared.

In Fig. 5, 126.7 degrees, an entirely new though faint spot, which we have called *h*, has formed midway between *a* and *f*. This drawing is the only one which has been secured of it. The previous night a drawing was made showing all the other eight areas, but nothing in the place of *h*. The following night *c* had disappeared and the brightness of all the other areas is recorded, but no mention is made of it. Moreover neither the drawings and estimates of brightness made December 25th, 1912, 118.7 degrees, and December 26th, 1912, 130.4 degrees, nor Figure 6 made January 31st, 1915, 132.2 degrees show any trace of it, although it was looked for carefully on the latter night.

An examination of Fig. 6, 132.2 degrees, shows clearly the location of two ridges situated on the western flank of the mountain, whose shape explains in part the forms of spots *b* and *c*. By colongitude 147.9 degrees the sun has set on the western slope and in that drawing and at 159.3 degrees the appearance is very similar to that at 183.6 degrees when Fig. 7 was drawn. The chief difference is that in the earlier drawings the spots *d*, *d'*, *e* and *f* all reached down to the level of the *mare*, while in the later one at 183.6 degrees *d'*, *e* and *f* have already begun to melt and disappear at their bases. This does not always happen, however, for on October 3rd, as late as 189.5 degrees, *d*, *d'*, and *e* are all shown as reaching down to the level of the *mare*, the terminator at this time passing through the base of the mountain.

As the result of observations made on 29 dates, extending over two years and a half, and lying between colongitudes 7.1 degrees and 189.5 degrees, we may summarize our results and state that spots *a*, *b*, and *c* first became visible at sunrise with full brilliancy 10, and that *d*, *d'*, *e*, *f* and *g* appear at 56 degrees with brilliancies 6 to 8, some two days after the sun first reaches the eastern side of the mountain. At about 80 degrees these latter points brighten, but with the exception of *d* never reach full brightness. Just before this *d* becomes very hazy for a couple of days and *a* less so. At 100 degrees *a*, *b*, and *c* begin to fade, and at 130 degrees the two last disappear, the sun setting upon that part of the mountain about two days later. At 130 degrees *g* begins to fade, but all the spots save *b* and *c* are visible until near sunset. Spot *h* appeared once for a short time at 127 degrees. Spot *c* is the one which varies most in size and shape during the lunation, and also from one lunation to another. Its variations are most marked between colongitudes 45 degrees and 70 degrees.

Other mountains in this immediate vicinity carry spots of variable size, and also present other features of interest. Just to the south of Pico, in longitude 9 degrees, latitude +43 degrees, lies the long elevated ridge Pico *B*, not to be confounded with the crater Pico *B*, located beyond the Teneriffe Mountains. *B* rises at the western end to a height of 5,000 feet above the surrounding plain, and is about 10 miles in length. On account of its isolated position it is visible in nearly its entire length at colongitude 7.1 degrees, the western end and middle peak being brilliant with snow. These spots are very persistent, and by 56.2 degrees are more conspicuous than anything on Pico itself. The northeastern side of the ridge is now beginning to show, and by 69.8 degrees is clearly seen. On July 23rd, 1912, 26.6 degrees, it is recorded "the upper slopes of Pico and nearly the whole of *B* are as bright as the brightest summits of the Alps." This certainly was not the case on January 24th or 25th, 1915, 19.8 degrees, 33.6 degrees, when the two spots were but little larger than indicated in Fig. 8. On September 23rd, 1912, 64.4 degrees, Fig. 8, a small but easily seen white spot, one mile from top to bottom by one quarter of a mile in width, lay upon the southern slope of the mountain half-way between the two larger spots. It was visible also September 24th and 25th, 78.5 degrees, 90.4 degrees, but the next night, 103.3 degrees, had disappeared. It was also visible August 26th, 1912, 84.3 degrees, but the next night had vanished. It did not appear this year at all, but on January 28th, 69.8 degrees, a faint line of snow lay along the crest of the mountain connecting the two large spots, thus lying at right angles to that seen in 1912. The next night it had already begun to melt at both ends, thus severing its connection with the spots.

A curious feature which shows well on this mountain appears at or a little earlier than 69.8 degrees. This is a row of almost contiguous bright dots which make their appearance along the eastern portion of the southern base (see Fig. 8), just where it rises from the plain. They are never very bright, seldom exceeding 7, but they gradually extend further toward the east. Two nights later another row extending the whole length of the northern base is also seen. Similar rows line both sides of Schroeter's Valley near Aristarchus, as also the rills of Hyginus and Ariadæus, although the last is rather faint. They look like columns of steam or cloud, and it is possible such may really be the case, as these are just the locations where hot springs occur in the case of the earth. If they are due to springs of water they need not necessarily be hot, since on account of the low atmospheric pressure, water would boil at the freezing point, 32 degrees, on the moon. Whatever their explanation, they form it is believed a hitherto nudescribed feature of the lunar landscape.

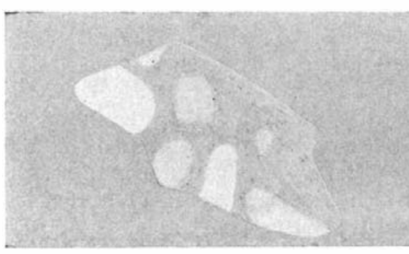


Fig. 5.

Fig. 6.

Fig. 7.

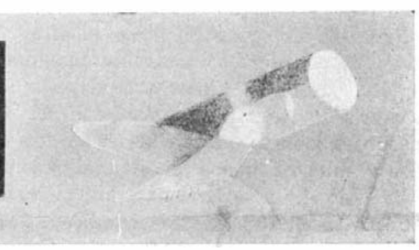


Fig. 8.

On September 25th, 1912, at 90.4 degrees, Pico *B* was steaming vigorously at its eastern end, the steam drifting off across the *mare* toward the north. This is the only record we have of steam clouds from this mountain. On February 2nd, 1915, 132.4 degrees, the western spot had vanished, while that at the middle was faint. September 29th, 1912, at 139.9 degrees, it too had gone. Somewhat earlier, spots had appeared on the northeastern face, and one near the middle was quite conspicuous, August 31st, 1912, at 148.1 degrees. Nothing of the sort was seen February 3rd, 1915, at 146.6 degrees. September 1st, 1912, at 166.2 degrees, a second smaller spot appeared just west of the other. The southwestern slope of the mountain was still visible, but the next night was enveloped in shadow, and another small spot had appeared on the northeastern side. This was our latest observation of it.

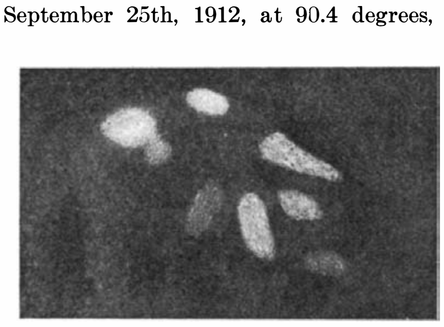


Fig. 9.

While these observations are all easy enough here in Jamaica, it is undoubtedly true that many of the phenomena recorded would be difficult with the inferior atmospheric conditions existing in the north. It has therefore always been the writer's aim to find and describe the most conspicuous changes that he has been able to detect. A marked irregular change recently occurred in Eimmart, and has been described by him in *A. N.* 4704, but there are regular changes constantly occurring within that crater, in some cases differing from one lunation to another, of about the same degree of visibility as those observed upon Pico.

With his 3-inch finder and a magnification of 180 he has been able to see clearly spot *d*, *d'* on Pico, and to suspect *f*, at about the time of full moon. With a somewhat larger aperture these and perhaps some of the others should be visible in the north, so that it should be possible to record the times of their appearance and disappearance. The same should be true of the two spots on Pico *B*.

Among the most difficult observations to confirm would probably be those relating to the so-called snow storm on Pico *d*. Where the seeing is continually bad, all outlines are indistinct, and little difference would therefore show even between *d* and *f*. Where on the other hand two or three diffraction rings are almost stationary around the brighter stars, with the full aperture of 11 inches, and a magnification of 800, as occurs here with our best seeing, 12, it is easy to see that details on the moon present a sharpness of outline quite unknown in the north. That certain bright spots such as Linné are always hazy is well known. The peculiarity of Pico *d* is that it is hazy only at specified seasons on the moon, when other neighboring and similar spots are sharp.

There are, however, other objects on the moon, similar in their characteristics to *d*, which are much easier to observe. One of these is Sulpicius Gallus *B*, so designated on Goodacre's map, but not shown by Neison. The crater is located in longtitude 351 degrees, latitude +20 degrees. On its eastern interior wall there is an intensely brilliant pear-shaped spot, very conspicuous just before full moon. It clearly changes its shape at different times, and is very hazy and indistinct between colongitudes 30 degrees and 120 degrees, although sharply defined earlier and later in the lunation. The duration of the indistinct period is thus much greater than on Pico *d*, and the change in appearance is so marked that the writer feels convinced it should be capable of detection in the north.

It has recently been found that the western end of the Straight Range presents changes that are fairly conspicuous. The sunlight first strikes it at colongitude 20 degrees. It is then intensely brilliant, especially at its northern edge. By 44 degrees it is rather less bright. By 70 degrees all the snow has gone except at the north and the bare rock, of brightness 6, looks red in contrast with the greenish *mare*. At 82 degrees faint whitish streams of brightness 7, begin to cover the rocky face. These have further brightened by 90 degrees, but by 103 degrees have again largely disappeared. The formation has been under observation for so short a period, however, that this description should be looked on merely as an indication of what my be expected, rather than as a finished report of what generally occurs.

Turning now to quite a different type of formation, we find scattered over the moon's surface, but especially in the equatorial regions, a series of small craterlets whose interior walls under all illuminations are of dazzling brilliancy. The floors of the smaller ones are also bright. One of the best known of these is Mösting *A*, some 5 miles in diameter, 3,000 feet deep, and situated in longtitude 5 degrees, latitude —3 degrees. On January 27th, 1915, at colongitude 56.3 degrees, the shadow still showed within the crater, but had entirely cleared the center of the floor, which appeared of a uniform brilliant white, without detail. On March 19th, 1913, 61.0 degrees, a minute black dot was detected at the center, of less than half a mile in diameter. It was also observed February 18th, 1913, 66.0 degrees. On January 28th, 1915, 70.1 degrees, the dot was clearly seen, was about a mile in diameter, and was of the same darkness as the region surrounding the crater. Accompanying the dot, and reaching from it toward the north, three-quarter of the way up to the rim, was a faint dark band one mile in breadth. This was observed March 20th, 1913, 71.4 degrees, though of slightly greater breadth and much greater density, and also on January 29th, 1915, 82.0 degrees. No change was detected March 21st, 1913, 85.7 degrees, but February 2nd, 1915, 132.5 degrees, the shadow had appeared on the eastern side, and the canal had almost completely faded away. The next night both the canal and central dot had vanished, and the floor was a uniform

white. The crater is clear of shadow for about 70 degrees of colongitude. Herschel *c* and Lalande *D* exhibit similar peculiarities. In *c* the canal extends toward the west, and in *D* northwest. In all cases as the sun rises higher and higher upon them the snow melts, and after midday forms again.

We will turn now to another type of white spot, the only one which has been investigated micrometrically. We refer here to Linné. An account of it is given in the *Harvard Annals* 61, 100, where measures by the writer in 1897, 8, by Prof. Barnard in 1902, 4, and by Prof. Wirtz in 1904, 6, are compared. All three agree in showing a marked diminution in size as the lunation progresses, up to a certain point, and after that an increase. According to the first two the minimum size is reached at about 12 degrees past midday for Linné, and the diameter about sunset is slightly less than about sunrise. Prof. Wirtz on the other hand finds the minimum size occurs 12 degrees before midday, and the diameter at sunset to be much larger than at sunrise, which would indicate a certain melting during the lunar night. All three agree, however, that the diameter fluctuates through a range of about 3 seconds. Irregular changes in the shape of the spot and its surroundings were noticed by all three observers.

Thus Prof. Barnard, on September 1st, 1903, detected a small bright point preceding the spot, 5.4 seconds from its center. On February 12th, 1905, Prof. Wirtz saw two irregular extremely delicate bright offshoots on the otherwise well-rounded spot, which offshoots the next day had disappeared, leaving the spot slightly elongated. Other observers besides the writer have found the size of the spot to increase slightly at the time of a lunar eclipse, so that a certain amount of literature upon the subject has already accumulated.

Mr. J. G. Burgess of the British Astronomical Association has recently called my attention to a spot situated some twelve miles north of Littrow *B*, in longitude 330 degrees, latitude +22 degrees, which is of the Linné type, and according to his description should be of greater interest than Linné itself at the present time, since it contains considerable fine detail close to the crater. His statements are in part confirmed by the writer's Photographic Atlas, H. A. 51. Mr. Burgess proposes soon to publish an account of his observations, the results of which in general resemble those made upon Linné. The writer examined the region February 2nd, 1915, at 132.8 degrees, and found a very thin white veil, whose density was 0.2 of a unit of brightness, covering it at that time. This veil was 6 miles in diameter. The next night it had entirely disappeared. This spot should be of particular interest at the time of a lunar eclipse, since the detail near the crater should make drawings available, thus avoiding some of the subjective systematic errors incident to micrometric measurements.

It has been the writer's object in the present article to show, not that periodic changes occur in the brighter regions of the lunar surface, for that was known before, notably in the case of the region surrounding Tycho, but to show in just what these changes consist. For this purpose he has selected small bright spots lying in regions showing sharply defined minute detail, in order that the minute changes everywhere occurring upon the moon could be more clearly defined. In order to make the study general, he has also selected the three different types of surface, elevations, depressions, and level areas.

The point of first interest perhaps in this investigation is to find when the spots reach their minimum size. Within the craters, the dark areas appear and disappear at about the same interval before and after midday, which therefore seems to be the time when the snow presents the smallest area. In the case of Linné, Prof. Barnard and the writer agreed that the minimum occurred one terrestrial day after lunar midday. Since the deviations of their observations from their respective curves were appreciably smaller than those of Prof. Wirtz, doubtless due to better atmospheric conditions in America, and since a minimum occurring after noon seems more probable than one occurring before it, the writer has adopted that view. It would certainly be of interest to prepare a series of drawings of the craterlet near Littrow *B*, and determine when its minimum occurs. In the case of Linné and apparently also of Littrow, the white spot is invisible both at sunrise and sunset. Just why this should be so is not very clear, but it would seem to indicate that the moisture can only escape from the vent about midday, and that toward sunset it all evaporates. Toward noon the evaporation occurs before it can get far from the vent, hence the spot is smaller, although brighter at that time than earlier or later.

In the case of the mountains, Pico, Pico *B*, and Straight Range, most of the white spots grow smaller the longer the sun shines on them. Those on the west side of the mountains, toward the rising sun, are of full brightness when the sun first strikes them. Those on the east do not deposit until the sun has been shining on the region for a day or two. It appears as if the ground some little way beneath the surface must be heated up before the moisture can escape. The spots on the western side, on the other hand, must be formed very shortly after the sun sets on them, but while it is still daylight in the surrounding region, for it is clear that nothing can deposit during the night, or both sides of the mountain would be brilliant when the sun first reached them. Pico *c* was seen in January, 1915, distinctly to grow in size, and spread over the dark surface of the mountain between colongitudes 9.0 degrees and 16.6 degrees. It then decreased in area until 32.9 degrees, Fig. 2, after which it increased a second time in size until 55.9 degrees, Fig. 3, and then rapidly diminished until 68.1 degrees. It had not changed at 81.8 degrees, Fig. 4, but when the region was next observed at 132.2 degrees, the spot was found to have disappeared.

The writer has sometimes been asked, "What reason is there to believe that there is ice upon the moon?" The answer is: "For the same reason that we believe there is ice upon Mars, because the phenomena observed can be more readily explained that way than any other." Whether the ice is deposited upon the surface, or floats as minute crystals just above it, in the form of surface clouds or fog, is not yet clear, but it is believed it occurs in both forms. Where the boundaries are sharply defined, it lies upon the surface. Where the boundaries are indistinct and hazy, as for instance in the case of Linné it is still uncertain. In the case of the bright rays surrounding Tycho, it is thought the ice crystals are supported in the lunar atmosphere like those terrestrial cirrus clouds to which we give the name of mare's tails.

London Traffic

THE battle for traffic between the road and rail in London is a source of never-failing interest to engineers and to students of passenger transportation problems in the metropolis.

Just how the contest is proceeding is made clear from a study of the report of the London Traffic Branch of the Board of Trade for 1914. From this we see that whereas in 1909 the number of journeys made by road was 60 per cent of the whole, the percentage by rail being 40, the corresponding figures in 1913 were 68 and 32, respectively.

The length of railways open for passenger use in the metropolitan area up to December 31st, 1913, was 669.2 miles, and the number of stations was 626, the corresponding figures ten years previously being 607.3 and 538, respectively, the appreciable increases being due principally to the development of the splendid system of tube railways during this period.

In dealing with mechanically-propelled road traffic the Board of Trade makes a statement that must not be allowed to go unchallenged, this being that "investigation proves that, as a whole, power-driven vehicles are twice as dangerous as horse-drawn vehicles." Such a statement gives a false view of the position of the motor in this respect unless it be pointed out that the much greater mileage covered by the power-driven vehicles must be borne in mind when comparing the two systems of traction. It is safe to say that every motor vehicle covers at least ten times the mileage of each horse-drawn vehicle in a given period hence the chances of accident are bound to be higher.

Believers in motor traction may take note of the fact brought out in the report that, though horse-drawn vehicles are a steadily diminishing factor in London traffic, the latest figures show that the accidents caused by these vehicles up to December 31st, 1913, were actually more numerous than was the case in the previous year. The reduced lighting of the streets cannot be given as any excuse for this increase, seeing that the present figures cover a pre-war period. But it is only to be expected that next year's report will show an increase due to this cause, as undoubtedly our lighting precautions against aircraft have resulted in many street accidents.

It is more than probable that our system of mixed traffic is responsible for many accidents that would not otherwise occur. It is potentially much more dangerous to cross a thoroughfare along which there are streams of traffic the units of which are moving at widely differing speeds than it is when the speeds are more uniform. As long as we have horsed traction running simultaneously with mechanical traction, accidents are bound to be numerous, notwithstanding the views of the board that the "best hope" of diminishing the 55 per cent of fatalities which are "due to the inadvertence of the pedestrian, lies with the pedestrian himself, now much more careful than he used to be."

Motors are rapidly replacing horses on our streets—only 4 per cent of the passenger vehicles are now horse-drawn—as far as private and passenger cars are concerned, but it will be a long time till the happy moment comes for the horse to be entirely banished from the metropolis, if we are to judge by the slow rate at which mechanical traction is replacing horsed transport in the direction of what may be termed in railway parlance "goods traffic." With all the progress that has been made in the development of the reliable, economical, and speedy motor for industrial purposes in recent years, it is a remarkable fact that in 1911 motors were used to the extent of only 6 per cent, the figures in 1913 being 12 per cent, and last year 15 per cent. Thus, with horses still making up 85 per cent of this class of traffic, it is clear that there is a vast field in front of the commercial vehicle branch of motor engineering. As the leeway is made up we may expect to find a distinct diminution in traffic congestion in the proportion of the ascertained relative congestion figures of the Traffic Branch of the Board of Trade. These figures show that if the light motor delivery van is given an obstruction factor of 1, then that for the fast heavy motor is 3, the slow, heavy motor being 5. Compared with the same standard of reference the horse-drawn vehicles are shown to be much more obstructive, the figures for the fast and slow one-horsed van being, respectively, 3 and 7, while those for similar two-horsed vans are 4 and 10.

The transition from animal to mechanical transport is likely to be slower this year than previously, owing to the war, but the retardation will be only temporary, a "lull before the storm"—of orders—in fact. The reason is that at the outbreak of the war our military authorities possessed only a relatively small amount of motor transport, and it was therefore necessary to commandeer whole fleets of commercial motors as well as the output of entire works manufacturing these vehicles. As a result, there is practically a famine in motors suitable for goods transport, and even if a business house were able to secure delivery in some way from the motor factory of an eligible vehicle it would probably be discovered and taken over by the War Office. Many firms, therefore, are being driven back to horses, of which there now seems to be no dearth, thanks to the omnipotency of the motor at the front. The phase is, however, but a passing one, and after the war there is bound to be a tremendous demand for motors to replace those lost in the present great conflict—motors that will be of finer quality than ever before, seeing that there will be embodied in them the numerous mechanical improvements and simplifications, the adoption of which has been forced at a time of strain and stress such as no piece of mechanism in the past has ever been required to encounter.

Just why the horse is at a discount at the front and to the fore in London traffic at the moment is clear if we consider for a moment the nature of the warfare in which the British army is now engaged. Practically speaking, it is siege warfare, for it is frequently as difficult to dislodge the Germans from their concrete trenches as it is to demolish a fort. Machinery, not horseflesh, is required for this class of work. Even the guns are now being moved about the battlefield by specially constructed motor tractors, seeing that the limit of weight of gun or howitzer that can be pulled by each horse over field tracks is in the neighborhood of 800 pounds. The field pieces used by ourselves and other combatants often greatly exceed the weight limit that can be dealt with by a gun team, hence the absolute necessity of some mechanical means of transport. In the case of the famous German 42-centimeter gun, which fires a shell weighing a ton and a quarter, this weapon for transport purposes is so constructed that it can be taken to pieces to form four separate loads, no one of which weighs more than twenty-five tons. Three road tractors, driven by internal combustion engines, are allotted to each twenty-five-ton load, and arrangements are made for dealing with the load by means of cables and drums should bad ground or severe inclines be encountered. Only machines could do this work, which far surpasses the limit of any practicable number of horses, and if required even bigger machines can be built to deal with yet greater loads should any of the combatants feel the need for a still more formidable weapon of offence than that which gave the *coup de grace* to the forts of Liège, Namur, and Antwerp.—*The London Daily Telegraph.*

Our Largest Trees

A RECENT effort by the American Genetic Association to locate and identify the largest American trees resulted in the discovery of a sycamore or buttonwood (*Platanus occidentalis*) which is more than 42 feet in circumference and 150 feet high. Other large trees reported were a valley oak (*Quercus lobata*) 37 feet in circumference, a chestnut (*Castanea dentata*) 35 feet in circumference, a tulip tree (*Liriodendron tulipifera*) 34 feet, a sassafras (*Sassafras variifolium*) nearly 16 feet, a white birch 12 feet, a pecan (*Carya Illinoensis*) 19 feet and a catalpa (*Catalpa specioso*) 16 feet in circumference. The largest elm reported was the "great elm" at Wethersfield, Connecticut, which is about 28 feet in circumference.—*The American Botanist.*

Insects and War*

Some Characteristics of Nusiances That Are Also Known in Times of Peace

By Arthur Everett Shipley, Sc.D., F.R.S.

The insects which prove such a nuisance to the fighter in time of war are the insects which equally affect man in time of peace. But owing to the different circumstances which arise when men are at war their effects are more violent and more persistent. Roughly speaking, we can divide these insect pests into two categories—(1) those which pierce the skin of men or of animals on which the soldier is to a great extent dependent, for instance, the horse; and (2) those which interfere with his food supplies. The latter, again, fall into two categories—(*a*) those which materially and substantially diminish that food supply, and by leaving their larvæ behind in the diminished stock render the food unpalatable; and (*b*) those which infect the food supply with pathogenic germs, such as those of enteric fever.

Among the insects which bite man, or, rather, pierce his skin, and which in times of peace can be kept in some sort of control, is the louse. In times of war, when men are herded together, with little or no opportunity of changing their linen, or washing, the louse is sure to appear and probably spread rapidly.

We will confine our attention to the genus *Pediculus*—*P. capitis*, the head-louse, and *P. vestimenti*, the body-louse. They do not arise, as the uninformed think, from dirt, though they flourish best in dirty surroundings. No specimen of *P. vestimenti* exists which is not the direct product of an egg laid by a mother-louse and fertilized by a father-louse. In considerable collections of men drawn from the poorer classes, some unhappy being or other—often through no fault of his own—will turn up in the community with lice on him, and these swiftly spread to others.

Like almost all animals lower than the mammals, the male of the body-louse is smaller and feebler than the female. The former attains a length of about 3 millimeters, and is about 1 millimeter broad. The female is about 3.3 millimeters long and about 1.4 millimeter broad. It is rather bigger than the hair-louse, and its antennæ are slightly longer. It so far flatters its host as to imitate the color of the skin upon which it lives; and Andrew Murray gives a series of gradations between the black louse of the West African and Australian natives, the dark and smoky louse of the Hindoo, the Orange of the Africander and of the Hottentot, the yellowish-brown of the North and South American Indians, and the paler brown of the Esquimo, which approaches the light dirty-gray color of the European parasites—

"As plump an' gray as onie grozet,"

as Burns has it.

The body-louse was the species dealt with in the recent observations undertaken by Mr. C. Warburton in the Quick Laboratory at Cambridge, at the request of the Local Government Board, the authorities of which were anxious to find out whether the flock used in making cheap bedding was instrumental in distributing vermin. Mr. Warburton at once appreciated the fact that he must know the life-history of the insect before he could successfully attack the problem put before him. At an early stage of his investigations he found that *P. vestimenti* survives longer under adverse conditions than *P. capitis*, the head-louse.

The habitat of the body-louse is that side of the underclothing which is in contact with the body. The louse, which sucks the blood of its host at least twice a day, is, when feeding, always anchored to the inside of the underclothing of its host by the claws of one or more of its six legs. Free lice are rarely found on the skin in western Europeans. But the underside of a stripped shirt is often alive with them.

After a great many experiments, Mr. Warburton succeeded in rearing these delicate insects, but only under certain circumscribed conditions; one of which was their anchorage in some sort of flannel or cloth, and the second was proximity to the human skin. He anchored his specimens on small pieces of cloth, which he interned in small test-tubes plugged with cotton wool, which did not let the lice out, but did let air and the emanations of the human body in. For fear of breakage the glass tube was inclosed in an outer metal tube, and the whole was kept both night and day near the body. Two meals a day were necessary to keep the lice alive. When feeding, the pieces of cloth, which the lice would never let go of, were placed on the back of the hand, hence the danger of escape was practically *nil*, and once given access to the skin the lice fed immediately and greedily.

* A paper read before the Royal Society of Arts.

His success in keeping lice alive was but the final result of many experiments, the majority of which had failed. Lice are very difficult to rear. When you want them to live they die, and when you want them to die they live and multiply exceedingly. A single female but recently matured was placed in a test-tube, and a male admitted to her on the second day. The two paired on the sixth day, and afterward at frequent intervals. Very soon after pairing an egg was laid, and during the remaining twenty-five days of her life the female laid an average of five eggs every twenty-four hours. The male died on the seventeenth day, and a second male was then introduced, who again paired with the female. The latter, however, died on the thirtieth day, but the second male survived.

The difficulty of keeping the male and female alive was simple compared with the difficulty of rearing the eggs. Very few hatched out. The strands of cloth upon which they were laid had been carefully removed and placed in separate tubes, at the same time being subjected to different temperatures. It was not, however, until the eggs were left alone undisturbed in the position where they had been laid and placed under the same conditions that the mother lived in that eight, and only eight, of the twenty-four eggs laid on the cloth hatched out after an incubation period of eight days. The remaining sixteen eggs were apparently dead. But the tube in which they were was then subjected to the normal temperature of the room at night (on occasions this fell below freezing-point), and after an incubation period of upward of a month six more hatched out. Hence it is obvious that, as in the case of many other insects, temperature plays a large part in the rate of development, and it becomes clear that the eggs or nits of *P. vestimenti* are capable of hatching out up to a period of at least from thirty-five to forty days after they are laid.

Difficult as it was to keep the adults alive, and more difficult as it was to hatch out the eggs, it was most difficult to rear the larvæ. Their small size made them difficult to observe, and, like most young animals, they are intolerant of control, apt to wander and explore, and less given to clinging to the cloth than their more sedentary parents. Naturally, they want to scatter, spread themselves, and pair.

Like young chickens, the larvæ feed immediately on emerging from the egg. They apparently molt three times, at intervals of about four days, and on the eleventh day attain their mature form, though they do not pair until four or five days later.

Mr. Warburton summarizes the life-cycle of the insects, as indicated by his experiments, as follows: Incubation period, eight days to five weeks; from larva to imago, eleven days; non-functional mature condition, four days; adult life—male, three weeks; female, four weeks.

But we must not forget that these figures are based upon laboratory experiments, and that under the normal conditions the rate may be accelerated. From Mr. Warburton's experience it is perfectly obvious that, unless regularly fed, body-lice very quickly die. Of all the verminous clothing sent to the Quick Laboratory, very little contained *live* vermin. The newly-hatched larvæ perish in a day and a half unless they can obtain food. These facts regarding the life-history of body-lice were fully confirmed by Dr. Fantham when working on the protozoal parasites of lice.

With regard to the head-louse—

"Ye ugly, creepin', blastit wonner,
Detested, shunn'd by saunt an' sinner,"

it is smaller than the body-louse, and is of a cindery-gray color. The female measures 1.8 millimeters in length and 0.7 millimeter in breadth. Like the body-louse, it varies its color somewhat with the color of the hair on the different branches of the human race. It lives among the hair of the head of people who neglect their heads; it is also, but more rarely, found among the eyelashes and in the beard. The egg, which has a certain beauty of symmetry, is cemented to the hair, and at the end of six days the larvæ emerge, which, after a certain number of molts, become mature on the eighteenth day. The methods adopted by many natives of plastering their hair with colored clay, or of anointing it with ointments, probably guards against the presence of these parasites. The Spartan youths, who used to oil their long locks before going into battle, may have feared this parasite. Some German soldiers, before going to war, shave their heads; thus they afford no nidus for *P. capitis*. The wigs worn in the late seventeenth and at the beginning of the eighteenth centuries undoubtedly owed something to the difficulty of keeping this particular kind of vermin down. The later powdering of the hair may have been due to the same cause.

P. capitis is in wartime less important than *P. vestimenti*. The former certainly causes a certain skin trouble, but the latter not only affords constant irritation, but, like most biting insects, from time to time conveys most serious diseases. *P. vestimenti* is known to be the carrier of typhus. This was, I believe, first demonstrated in Algeria, but was amply confirmed last year in Ireland, when a serious outbreak of this fever took place, though little was heard of it in England. Possibly, *P. capitis* also conveys typhus, but undoubtedly both convey *Spirochaeta recurrentis*—the cause of relapsing or recurrent fever. The irritation due to the body-louse weakens the host and prevents sleep, besides which there is a certain psychic disgust which causes many officers to fear lice more than they fear bullets. Also by rubbing or scratching the lice may be crushed on the skin. The germs of disease within them may thus be inoculated directly into the blood through the surface of the skin damaged by the scratch. Soldiers should, further, always avoid touching their eyes after scratching insect-bites. Lice are the constant accompaniment of all armies; and in the South African war as soon as a regiment halted they stripped to the skin, turned their clothes inside out and picked the *Anoplura* off. As a private said to me: "We strips and we picks 'em off and places 'em in the sun, and it kind o' breaks the little beggars' 'earts!"

There were serious outbreaks of typhus during the recent Balkan wars among the combatants, prisoners, and refugees. The epidemics were spread by lice. Again, typhus and relapsing fever are endemic in various areas along the eastern front of the present theater of war, and are even now causing trouble in Serbia.

Another insect which pierces the skin of man and destroys the continuity of his integument is the bed-bug, *Cimex lectularius*.

The common bed-bug seems to have arrived in England about the same time as the cock-roach, that is, over four hundred years ago, early in King Henry VIII's reign. Apparently it came from the East, and was for many years confined to seaports and harbors. It seems to have been first mentioned by playwriters toward the beginning of the seventeenth century. The sixteenth century dramatists could never have resisted mentioning the bug had it been in their time a common household pest. It would have appealed to their sense of humor.

How the insect got the name of "bug" is unknown. It has been suggested that the Old English word "bug," meaning a ghost or phantom which walked by night, has been transferred to *Cimex*. This may be so, but the "Oxford English Dictionary" tells us that proof is lacking.

The insect is some 5 millimeters in length, and about 3 millimeters in breadth, and is of a reddish- or brownish-rusty color, fading into black. Its body is extraordinarily flattened, so that it can readily pass into chinks or between splits in furniture and boarding, and this it does whenever daylight appears, for the bug loves darkness rather than light. The head is large, and ends in a long, piercing, four-jointed proboscis, which forms a tube with four piercing stylets in it. As a rule, the proboscis is folded back into a groove, which reaches to the first pair of legs on the under surface of the thorax. This folding back of the proboscis gives the insect a demure and even a devout expression; it appears to be engaged in prayer, but a bug never prays. The head bears two black eyes and two four-jointed antennæ. Each of the six legs is provided with two claws, and all the body is covered with fairly numerous hairs. The abdomen shows seven visible segments and a terminal piece.

The bug has no fixed period of the year for breeding; as long as the temperature is favorable and the food abundant generation will succeed generation without pause. Should, however, the weather turn cold the insects become numbed and their vitality and power of reproduction are interrupted until a sufficient degree of warmth returns.

Like the cockroach, the bed-bug is a frequenter of human habitations, but only of such as have reached a certain stage of comfort. It is said to be comparatively

rare in the homes of savages; but it is only too common in the poorer quarters of our great cities. The iron bedstead, which has so rapidly replaced the wooden bedstead, was at one time thought to render the bug's position untenable. This is not so. Bugs will shelter in its metallic crevices almost as comfortably as in the wooden chinks of its predecessor. Its presence does not necessarily indicate neglect or want of cleanliness. It is apt to get into trunks and luggage, and in this way may be conveyed even into the best-kept homes. It is also very migratory, and will pass readily from one house to another, and when an infested dwelling is vacated these insects usually leave it for better company and better quarters. Their food supply being withdrawn, they make their way along gutters, water-pipes, etc., into adjoining and inhabited houses. *Cimex* is particularly common in ships, especially emigrant ships, and, although unknown to the aboriginal Indians of North America, it probably entered that continent with the "best families" in the "Mayflower."

Perhaps the most disagreeable feature of the bed-bug is that it produces an oily fluid which has a quite intolerable odor; the glands secreting this fluid are situated in various parts of the body. The presence of such glands in free-living Hemipterous insects is undoubtedly a protection—birds will not touch them. One, however, fails to see the use of this property in the bed-bug. At any rate, it does not deter cockroaches and ants, as well as other insects, from devouring the *Cimex*. There is a small black ant in Portugal which is said to clear a house of these pests in a few days; but one cannot always command the services of a small black Portuguese ant.

Another remarkable feature is that the insect has no wings, although in all probability its ancestors possessed these useful appendages. As the American poet writes:

"The Lightning-bug has wings of gold,
The June-bug wings of flame,
The Bed-bug has no wings at all,
But he *gets* there all the same!"

The power of "getting there" is truly remarkable. Man, their chief victim, has always warred against bugs, yet, like the poor, bugs "are always with us." I heard it stated, when I was living in Southern Italy, that if you submerged the legs of your bed in metal saucers full of water and placed the bed in the center of the room, the bugs will crawl up the wall, walk along the ceiling and drop on to the bed and on to you. Anyhow, whether this be so or not, there is no doubt that these insects have a certain success in the struggle for life, and only the most systematic and rigorous measures are capable of ridding a dwelling of their presence.

The eggs of the bed-bug are pearly white, oval objects, perhaps one millimeter in length. At one end there is a small cap surrounded by a projecting rim, and it is by pushing off this cap, and through the orifice thus opened, that the young bug makes its way into the outer world after an incubation period of a week or ten days. There is no metamorphosis—no caterpillar and no chrysalis stages. The young hatch out in structure miniatures of their parents, but in color they are yellowish-white and nearly transparent. The young feed readily, and feeding takes place between each molt, and the molts are five in number, before the adult imago emerges. This it does about the eleventh or twelfth week after hatching. These time limits depend, however, upon the temperature after hatching, and the rate of growth depends not only upon the temperature, but also upon the amount of food.

When bred artificially, and under good conditions, the rate of progress can be "speeded up" so that the eggs hatch out in eight days, and every following molt takes place at intervals of eight days, so that the period from egg to adult can be run through in as short a time as seven weeks. Unless fed after each molt, the following molt is indefinitely postponed. Hence it follows that in the preliminary stages bugs must bite their hosts five times before the adult form emerges, and the adult must, further, have a meal before she lays her eggs. The eggs are deposited in batches of from five to fifty in cracks and crevices, into which the insects have retired for concealment.

Bugs can, however, live a long time without a meal. Cases are recorded in which they have been kept alive for more than a year incarcerated in a pill-box. When the pill-box was ultimately opened, the bugs appeared to be as thin as oiled paper, and almost so transparent that you could read the *Times*[1] through them; but even under these conditions they had managed to produce offspring. De Geer kept several alive in a sealed bottle for more than a year. This power of existing without food may explain the fact that vacated houses occasionally swarm with bugs even when there have been no human beings in the neighborhood for many months.

The effect of their bite varies in different people. As a rule, the actual bite lasts for two or three minutes before the insect is gorged, and at first it is painless. But very soon the bitten area begins to swell and to become red, and at times a regular eruption ensues. The irritation may be allayed by washing with menthol or ammonia.

The bed-bug has been accused of conveying many diseases. How far it does this in nature seems uncertain. But it certainly contains certain pathogenic spirochaetes, and monkeys have been infected in the laboratory with these.

In India the bed-bug is under suspicion of spreading *kala-azar*, or "black fever." Other insects probably convey similar diseases in various parts of the tropics and sub-tropics, as is indicated by the recent experiments of Prof. Laveran and Dr. Franchini in Paris, and Drs. Fantham and Porter in Cambridge. Whether bugs be guilty of these crimes or not, they are the cause of an intense inconvenience and disgust, and should, if possible, be dealt with drastically. At the present time there are rumors that some of our largest camps are infested with these insects, and there seems no doubt that some of the prisoners and refugees to this country have brought their fauna with them, and this fauna is very capable of spreading in concentration camps. The erection of wooden huts—no doubt a pressing necessity—affords convenient quarters for these pests.

A third biting insect is the flea.

Fleas are temporarily parasitic on many mammals and birds, but some mammals and some birds are much freer from fleas than others. As the flea is only on its host for part of the time, it has to put in the rest of its existence in some other place, and this, in the case of the human flea, is usually the floor, and in the case of bird-fleas the nest; from these habitats they can easily regain their hosts when the latter retire to rest. But larger numbers of Ungulates—deer, cattle (except when domesticated), antelopes, goats, wild boars—usually sleep in different places each recurrent night, and to this is probably due the fact that, with the exception of two rare species—one taken in Northern China and the other in Transcaucasia—the Ungulates have furnished descriptive science with no fleas at all. Both of these Ungulate fleas are allied to the burrowing-fleas, or "chigoes."

I know none of my hearers will believe me when I say that the same is true of monkeys; but I do this on the undoubted authority of Mr. Harold Russell, who has recently published a charming little monograph on these lively little creatures. Monkeys in nature are cleanly in their habits; and although in confinement occasionally a human flea attacks them, and although a chigo bores sometimes into the toes of a gorilla or chimpanzee, "speaking generally, it may be said that no fleas have been found truly parasitic on monkeys." Whatever the monkeys are looking for, it is not the fleas. What they seek is, in effect, little scabs of scurf, which are made palatable to their taste by a certain sour sweat.

As a rule, each host has its own species of flea, but though, for the most part, *Pulex irritans* is confined to man it is occasionally found on cats and dogs, while, conversely, the cat and dog fleas (*Ctenocephalus felis* and *Ct. canis*) from time to time attack man.

The bite of the flea is accompanied by the injection of the secretions of the so-called salivary glands of the insect, and this secretion retards the coagulation of the victim's blood, stimulates the blood-flow, and sets up the irritation we have all felt.

It is only a few years ago that the spread of bubonic plague was associated first with rats, and then with rat-fleas; and at once it became of enormous importance to know which of the numerous species of rat-fleas would attack human beings. The Hon. Charles Rothschild, who has accumulated a most splendid collection of preserved fleas in the museum at Tring, had some years ago differentiated from an undifferentiated assemblage of fleas a species first collected in Egypt, but now known to be the commonest rat-flea in all tropical and sub-tropical countries. This species, *Xenopsylla cheopis*—and to a lesser extent *Ceratophyllus fasciatus*—unfortunately infests and bites man. If they should have fed upon a plague-infected rat and subsequently bite man, their bites communicate bubonic plague to human beings. Plague—the Old English "Black Death"—is a real peril in our armies now operating in Asia and in certain parts of Africa.

Just as some fleas attack one species of mammal or bird and avoid closely-allied species, so the human flea has its favorites and its aversions. There is a Turkish proverb which says, "An Englishman will burn a bed to catch a flea," and those who suffer severely from flea-bites would certainly do so. The courage of the Turk in facing the flea, and even worse dangers, may be, as the schoolboy wrote, "explained by the fact that a man with more than one wife is more willing to face death than if he had only one." But there are persons even a flea will not bite. Mr. Russell has reminded us, in his preface, of the distinguished lady who remarked, "*Quant à moi ce n'est pas la morsure, c'est la promenade!*"

(*To be concluded.*)

[1] Only the larger print, such as the leading articles and letters from admirals.

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