This gas is stated to have an illuminating power of fully 56 candles, and to lose little either by standing or by carriage to considerable distances.

As such petroleum gas has about 3·5 times the illuminating power of 16-candle coal-gas, it follows that, so far as illuminating purposes are concerned, the gas producible from one gallon of oil by this process is equal to some 525 cubic feet of coal-gas of 16-candle value. I shall later on refer to the heating value of this petroleum gas, but I have now justified the statement with which this section commenced, viz., that petroleum is virtually liquefied gas in a peculiarly portable condition. Hence in all states petroleum can be used as an illuminant as well as a fuel, whereas coal and peat can only be used as illuminants in so far as they can afford carburetted gas.

Let me now proceed to justify the further statement that petroleum is the most concentrated, and, on the whole, the most portable of all the natural fuels met with in considerable quantities.

Weight for weight the efficiency of liquid petroleum in steam-raising is much greater than that of coal. The estimates of relative value necessarily vary with different portions of the crude material used, and with the quality of coal employed in the comparative trials; hence some of the statements of results are often rather vague. Thus M. d'Allest found that one pound of refined petroleum evaporated 12·02 pounds of water, while only 6·5 pounds were evaporated per pound of a rather poor steam coal. The American results with crude petroleum and Pittsburg coal gave respectively 15 and 7·2 pounds of water per pound of fuel. Prof. Unwin has recently compared petroleum with Welsh coal in steam-raising, the oil being injected by a steam jet through a highly heated coil and then burned perfectly with a clear flame. In his trials with a not particularly efficient boiler he found that 12·16 pounds of water were evaporated per pound of petroleum, and this result he considers about 25 per cent. better than that afforded by the steam coal. These results agree with those of M. d'Allest so far as the effect of petroleum is concerned, but the coals compared were different in value for steam-raising. Hence for an average coal the proportion is nearly three to two; in other words the practical heating effect of one ton of coal can be obtained by the combustion of only two-thirds of a ton of petroleum, while the comparison with the heavy oils would probably be still more in favour of liquid fuel. Petroleum has another advantage over coal in the matter of storage room, as one ton of the liquid occupies only four-fifths of the space of the same weight of coal, so that the bulk of the petroleum required to perform the same work in heating as one ton of average coal is little more than half that of the latter. It follows that a steamer constructed to carry 1000 tons of coal could, if provided with suitable tanks, carry 1200 tons of petroleum, equal in fuel value to about 1900 tons of coal. In addition, the liquidity of petroleum permits it to be pumped and conveyed long distances by gravitation in tubes so that its transport in bulk and in detail is easy. Therefore petroleum is not only a much more concentrated fuel than coal, but it is eminently portable as well and convertible with much greater facility into permanent gas. Against these advantages must, however, be set the inflammability of petroleum, and consequent greater risk of fire.

Now we have to consider the question of relative cost of petroleum used as fuel in liquid or gaseous form as compared with coal—the latter being our standard for reference as in the case of peat. We have already seen that about two-thirds of a ton of petroleum can do the same amount of work in heating as one ton of coal; therefore petroleum, when burned directly, cannot economically replace coal unless two-thirds of a ton of the liquid can be purchased for less than the cost of one ton of coal. We know the cost of ordinary lamp petroleum in these islands is at present far beyond that limiting value; even the heavy oils which are not good enough for lamps, and yet are too 'thin' for lubricants, only compare favourably with coal where the latter has to be carried long distances, and is therefore dear. However, all practical difficulties having been overcome in the use of these heavy oils for steam-raising, a comparatively small advance in the general price of coal would at once render them economical for industrial use as fuel.

But when we compare petroleum gas with ordinary coal-gas the comparison is much more favourable to the liquid fuel; unlike coal, petroleum is already more than half-way on the road to conversion into gas. As you know, one ton of coal affords about 9500 cubic feet of 16-candle gas. On the other hand, one ton of oil of sp. gr. 0·85 can afford about 24,000 cubic feet of gas, having an average illuminating power of 60 candles, or the equivalent of about 70,000 cubic feet of 16-candle value, and this rich gas admits of preparation on the small scale suited to country places, while the retorts used in the production of the gas can be heated by petroleum. The petroleum gas of some 60-candle power is said to be producible at about 6s. per 1000 cubic feet. If we were to assume that the calorific value of the gas is directly proportional to its illuminating power the cost would correspond to about 1s. 7d. per 1000 cubic feet of 16-candle coal-gas. But the facts do not justify the assumption, as the calorific value of methane is known to be greater than that of the heavier carbides to which the high illuminating power is due; hence the comparison is probably less favourable to petroleum gas by about 25 per cent., though further experimental evidence is wanting on this point. However, even after this deduction, petroleum gas is the cheaper fuel as well as illuminant.

The necessary links between the elements of the trilogy on coal, peat, and petroleum are now, I think, sufficiently evident. If we desire to use each fuel in such a way as to develop most economically and conveniently its store of heat energy, we must first partially or perfectly gasify it. The newest member of the triad—petroleum—is the one which lends itself most easily and completely to such treatment, in consequence of its physical condition and chemical characters. It is also the material that we must expect to facilitate the production of cheap gaseous fuels from coal and peat which shall at the same time possess sufficient illuminating power for most purposes. Chemical industries would probably benefit to a greater extent than others by the supply of cheap fuel of the kind in question; hence I have ventured to tax your patience by dwelling on this topic in your presence to-day.

SUGAR-CANE BORERS IN THE WEST INDIES.

MR. BLANDFORD'S report on sugar-cane borers, published in the *Kew Bulletin* for July and August last, deserves more than a passing notice.

The report contains a plate of the insects in question, which will render their identification easy.

The first is a caterpillar and moth, *Chilo saccharalis;* the second a weevil, *Sphenophorus sacchari;* but the principal attention in the report is paid to the shot borer, *Xyloborus perforans*, a beetle which has lately caused considerable loss to growers of sugar-canes in Trinidad. These losses have been so large that on some estates thirty per cent. of the sugar crop has been destroyed, and in some fields fifty per cent., presumedly by the devastations of this beetle.

This beetle *X. perforans* is to be found over a very large area in the tropics; it is the same species that has done so much damage to wine and beer casks; it has been found in India, the Malay Archipelago, Madeira, Mauritius, North and Central America, Brazil, Guiana, Peru, and probably in Australia, so that no sugar-producing country can consider itself free from the fear of its ravages.

Mr. Blandford's report is interesting and valuable, not only for the amount of information it gives relative to this most destructive insect; but also for the way in which he points out what remains still to be investigated on the subject; so that it not only furnishes valuable information to the planter in the West Indies, but also tells him what course his further investigations should take; and it might well serve as a model to future observers in drawing up similar reports.

"The chief subject for investigation," to quote Mr. Blandford, "is the relation of the insect's attacks to the health and condition of the canes, whether it (the shot borer, *X. perforans*) is a true destroyer, or merely a follower and manifestation of antecedent and more serious injury:" this question, Mr. Blandford says, "I do not attempt to solve; it can only be studied in all its bearings by observers on the spot;" and he further gives a list of definite points which require inquiry and solution.

There is no doubt that the presence of *X. perforans* is usually accompanied by the sugar-boring caterpillar, *C. saccharalis*, and the weevil, *S. sacchari*, and also with fungoid growths, which may of themselves account for the acidification of the juices of the cane, which is apparent in canes attacked by the shot borer; but whether or not the shot borer attacks healthy canes is a question on which there is much diversity of opinion, and we hope that bringing the question before our readers will lead to more observations and experiments to decide this important question, as "while there is no proof, there is a strong presumption that *X. perforans* cannot begin the attack." Still there is much difference of opinion, as the Trinidad Commission, which investigated the subject, "believes that the beetle is the primary cause of the disease, and that it is immaterial whether the cane is healthy or not;" others believe that it is only canes which are "already physically weakened by other causes which are attacked by it."

The Transparent Cane and Caledonia Queen enjoy an entire immunity from the attack, "even when growing side by side with badly infested Bourbon canes, and varieties raised by seed show no signs of being attacked." It is therefore suggested that perhaps the Bourbon cane, enfeebled by long cultivation on the same lands and degenerated by careless ways of propagation, has become powerless to resist the attacks, and planters in their investigation must consider the possibility of attacks "being favoured by constitutional weakness which in no way implies want of care in cultivation, but perhaps the reverse."

The enemies of the shot borer are still to be found.

An important lesson taught by this report to the planter is the necessity of varying the description of canes grown and the great value of the new seed canes raised in Barbados.

S. N. C.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 19.—M. Duchartre in the chair.—On the white rainbow, by M. Mascart. This phenomenon, usually known under the name of Ulloa's circle, is explained, not on the untenable assumption of water vesicles, but of very minute drops as constituting the mist upon which it is seen. The diminution of the diameter of the drops causes a displacement of the first maximum of the interference fringes which produce the supernumerary arcs. The relative intensities of the various colours retain equal values long enough to make the rainbow appear achromatic, with perhaps a slight red coloration along the outside. The radius of such a circle has been known as small as 33° 30′.—Observations of the new planet Wolf (1892, Sept. 13), and of the planet Borrelly-Wolf (Erigone?), made at the observatory of Paris (west equatorial), by M. Bigourdan.—On a recurring series of pentagons inscribed to the same general curve of the third order, by M. Paul Serret.—On the production of the spark of the Hertz oscillator in a liquid dielectric instead of air, by MM. Sarasin and De la Rive. The two balls of 3 or 4 cm. in diameter, between which the Ruhmkorff discharge takes place in the Hertz oscillator, were plunged into an insulating fluid. This was, in the first place, olive oil, contained in a cylindrical vessel, 20 cm. in diameter, pierced laterally to admit the end branches of the oscillator. Sparks 1 cm. long were obtained, giving a characteristic sound, louder than that of a discharge through air. The effect on the resonator is notably increased by the arrangement, most brilliant sparks being produced. The interferences of the electric force by reflection from a plane metallic surface give the same results as in air. During the discharge, the oil is carbonized and loses its transparency, but without affecting the intensity. Similar experiments were made with essence of terebenthine and petroleum, but the oil proved the safest and most advantageous medium.—The action of bromine in presence of aluminium bromide on the cyclic chain carbon compounds, by M. W. Markovnikoff. It has been shown that a small quantity of bromide or chloride of aluminium added to the bromine produces a vivid reaction with the carbon compounds of the aromatic series, usually resulting in substitution-products of a crystalline form. Further experiments show the generality of the reaction for all the hydrocarbons of the series C_nH_{2n} which were examined. It has been studied chiefly as regards the naphthene (hexacarbon) series, and may be expressed by the general equation—

$$C_6H_{12-n}B_n + Br_{12-n} = C_6B_{6-n} + 6HBr.$$

The rule seems to be that the action of the bromine on the naphthenes at the ordinary temperature takes place principally on the hydrogen atoms of the cyclic chain, transforming them into benzene nuclei, in which all the hydrogen atoms are replaced by bromine, whilst the lateral chains remain intact. It is found that besides the bodies of the aromatic and naphthene series, the hydrocarbons of the paraffin series also react easily in presence of $AlBr_3$.—The rotatory power of fibroin, by M Leo Vignon.—Experimental researches on the bulb centre of respiration, by MM. J. Gad sand G. Marinesco.—Influence of continuous and discontinuous electric light upon the structure of trees, by M. Gaston Bonnier. Out of three lots of plants, one was submitted to a constant electric illumination, another to an illumination alternating with twelve hours' darkness, and a third was left to develop in ordinary daylight. The experiments were carried out in the electric pavilion of the Central Markets at Paris. The temperature was pretty constant (between 13° and 15°); the light was given by arc lamps in shades, and the trees—pines, beeches, oaks, and birches—were surrounded by glass, the air being gradually renewed. It was found that continuous electric light produced considerable modifications of structure in the leaves and shoots of the trees. The plants breathed, assimilated, and secreted in a continuous manner, but they appeared as if encumbered by this continuity, and showed a simpler structure. The shoots were very green, the leaves more open, less firm, and smaller. Differentiation was less decided in every respect. In the specimens exposed to intermittent illumination the results were very similar to those obtained under normal conditions.—On the discovery of the line of no declination, by M. W. de Fonvielle. From an inspection of geographical maps preceding or contemporaneous with the discovery of America it appears certain that Columbus was the first to discover the variation of the compass. Indeed, it was the rapidity with which the observed declination diminished which produced consternation among his seamen, whom he could only save from a panic by persuading them that the pole star had changed its place, while the needle remained a true guide. The stratagem succeeded, but Columbus suspected that the radius of curvature of the earth was different at the Sargasso sea, and that the line of no declination represented a natural frontier between the territories of Europe and Asia. This natural frontier was adopted by the Pope Alexander VI. in his division of the new world between the rival aspirants. Columbus himself found that the line did not coincide with a meridian during his third voyage, but the illusion guided even Magellan, and was only dispelled by Halley's magnetic chart in 1700.

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