More than half the area of the State forests is already under the high forest treatment, and consists chiefly of highly-productive silver-fir and beech forest in the Vosges; forests of *Pinus Laricio* and *Pinus Pinaster* in Corsica, which only yield poor returns on account of the frequency of forest fires; beech forests in Normandy with a small proportion of oak, and extensive oak forests on the Loire and its tributaries, where beech is kept subservient to the principal species. The maritime pine forests of the Landes and Gironde yield large quantities of resin and turpentine, as well as inferior timber, pit-props, &c.

The communal forests are distributed as follows:—

	Percentage of area.
Simple coppice	14·7
Coppice-with-standards	53·2
,, under conversion to high-forest ...	1·0
High-forests	31·1

The communal simple coppice areas chiefly supply fuel to villagers, and consist mainly of *Quercus Ilex* in the south, and of common oak and other species in the Ardennes and lower slopes of the Alps, near the villages and below the coniferous forests of the higher zones.

Coppice with-standards is the commonest mode of management of communal forests, and is distributed chiefly in the temperate regions of hills and plains of the north-east of France, and little of this area is being converted to high-forest, as the people do not care sufficiently for the benefit of futurity to sacrifice a considerable part of their present revenues.

The high forests belonging to communes, &c., are chiefly situated in the Vosges, Jura, Alps, Pyrenees, and in Corsica, consisting chiefly of conifers mixed with beech.

Detailed tables are given regarding the yield of the forests in material and money.

Thus the production of the forests during the year 1892 was as follows:—

—	State forests.	Communal forests, &c.
	c. feet	c. feet.
Wood	96,051,592	169,275,133
	cwt.	cwt.
Cork	2,300	6,100
Bark for tanning ...	283,000	463,000
Crude resin	37,800	16,300
Total value ...	£846,144 at 25 fr. = £1	£1,321,804

The average annual production per acre of the wooded area of the forests is as follows:—

	c. feet.		s.	d.
State forests	43½	...	9	5
Communal and other forests...	37	...	5	10

It is evident that the State forests yield more wood, and of a better quality, than the communal forests.

Leaving out the Departments of the Seine and Corréze, where the production in quantity of material and money is abnormally high, the areas of State forests in these Departments being inconsiderable, the forests of the Vosges head the list with an annual yield of 7·136 c.m. per hectare, equivalent to 101 c. feet per acre, and worth £1 3*s.* 4*d.*

This return is exceeded in value, though not in quantity, by the forests of the Doubs, where there is much oak grown as well as silver-fir, and the yield is 5·867 c. metres per hectare = 84 c. feet per acre, and worth £1 7*s.* 5*d.* an acre.

The productiveness in different classes of material of the different forests are as follows:—

STATE FORESTS.

Broad-leaved Species.

		Percentage of yield.
Timber	Oak 20 in. in diameter and above ...	5
	Do. less diameter	5
	Other broad-leaved species	6·1
Poles	... ...	3·8
Firewood	... ...	57·1

Conifers.

Timber	Exceeding 20 in. in diameter... ...	9·4
	Less than ,, ...	5·3
Poles	... ...	0·6
Firewood	... ...	7·7

The proportions of the yield of broad-leaved and coniferous timber is as follows:—

	Percentage.
Broad-leaved...	77
Coniferous	23

It is noted that the broad-leaved species yield 74 per cent. of firewood, while the conifers only yield 33 per cent.

In the communal and other forests the production is as follows:—

	Percentage.
Broad-leaved	81·3
Coniferous	18·7

And the percentage of firewood in the former case is 86 per cent., whilst for the coniferous forests it is 25 per cent. These forests are less productive in timber, and especially in timber exceeding 20 inches in diameter, than the State forests, which accounts for their reduced money return.

If we omit the large sum of £99,300 spent in 1892 on planting-up dangerous mountain sides and regulating the beds of mountain torrents, and £8,400 spent on fixing shifting sands, the cost of maintenance of the whole of the productive forests referred to in 1892 was £397,080, or about 1*s.* 2*d.* per acre, which must therefore be deducted from the yield of the forests to determine their net revenues per acre.

The following is a complete statement of the French forest charges for 1892:—

	£
Establishment	231,800
Forest schools	6,880
Works of improvement in the forests ...	58,000
Mountain *reboisement*	99,300
Fixing shifting sands	8,400
Working plans and fellings	16,000
Management of *chasses* which are not leased	2,000
Taxes	72,400
Law and other charges	10,000
	£504,780

Of this amount £41,268, or about 2*d.* an acre, is refunded to the State by the communes and public establishments for the management of their property. W. R. FISHER.

THE PROPERTIES OF LIQUID ETHANE AND PROPANE.

A COMPREHENSIVE study of the properties of these primary hydrocarbons in the liquefied condition has been made by Dr. Hainlen in the laboratory of Prof. Lothar Meyer at Tübingen, and an account of his work will be found in the current issue of *Liebig's Annalen.* Owing to the greater ease with which it undergoes liquefaction, propane was first investigated. The hydrocarbon was obtained in a state of purity by means of the admirable method of preparation discovered in the same laboratory in the year 1883 by Köhnlein, which consists in heating propyl iodide with aluminium chloride in a sealed tube to 130°. After subjection to this temperature for twenty hours the tube was allowed to cool, and subsequently placed in a freezing mixture; while immersed in the latter it was found practicable to open it without danger or loss, the accumulated gas being readily transferred to a gas-holder over water.

In order to determine the boiling-point of propane, the purified gas was first condensed to the liquid state in a U-tube surrounded by solid carbon-dioxide. It was then transferred to the special boiling-point apparatus by evaporation and re-condensation, the last traces of impurities being eliminated by this process of repeated distillation. The special apparatus consisted of a glass tube closed at the lower end, furnished with a side tube for the entrance of the gas, and with a stopper at the open end perforated for the passage of an exit-tube and a thermometer. The upper half of the cylinder was surrounded by solid carbon-dioxide, and the lower portion was protected by a mantle of badly-conducting felt. Upon the entrance of

the gas the air was expelled by the exit-tube, and the gas which condensed in the upper portion of the cylinder collected in the lower portion. When the protecting mantle was removed the relatively warm air soon promoted ebullition, and the escaping vapour was as rapidly recondensed in the cooled upper portion of the cylinder, and fell back into the lower. If the hand were brought into the proximity of the cylinder, the boiling became most vigorous. At first propane usually boils irregularly, quiescent intervals being succeeded by almost explosive ebullition; but after a short time the formation of vapour becomes perfectly regular, and a mercury thermometer dipping in the liquid registers a temperature of − 38°. After comparison of the latter with an air thermometer, the correct temperature of the boiling-point of propane is found to be − 37° at 760 m.m. pressure.

Propane may safely be sealed in strong glass tubes after condensation by means of solid carbon dioxide, and thus preserved in the liquid state. It is a perfectly colourless liquid, but much more viscous than liquid carbon dioxide. The critical temperature was determined by use of such a tube half filled with the liquid. The tube was immersed alongside a thermometer in a bath of liquid paraffin, furnished with a suitable stirrer. Upon heating the apparatus to 101° the liquid meniscus commenced to become hazy, and the distinction between gas and liquid became less and less pronounced until at 110° all trace of it had disappeared. Upon cooling, the well-known nebulosity was observed at 102°, and this temperature is considered to be a close approximation to the critical temperature of propane.

The vapour pressures of propane for different temperatures up to 12°·5 were determined by enclosing a quantity of the liquefied hydrocarbon in one limb of a U-tube and dried air in the other limb, the two being separated by means of a short column of mercury. The closed apparatus was then cooled to various temperatures in suitable baths, and the vapour pressures calculated from the amount of compression of the air column. The vapour pressures for temperatures superior to the ordinary were determined by use of the Caillétet apparatus and spring manometer. The following table represents a summary of the results:

Temperature.	Pressure in atmospheres.	Temperature.	Pressure in atmospheres.
− 33°	1·8	+ 1°	5·1
− 19°	2·7	+ 5°·5	5·9
− 15°	3·1	+ 12°·5	7·1
− 11°	3·6	+ 22°	9·0
− 5°	4·1	+ 53°	17·0
− 2°	4·8	+ 85°	35·0
		+ 102°	48·5

The critical pressure of propane corresponding to the critical temperature of 102° is consequently 48·5 atmospheres.

Dr. Hainlen has also determined the density of liquid propane at several temperatures. It is 0·536 at 0°, 0·524 at 6°·2, 0·520 at 11°·5, and 0·515 at 15°·9, compared with water at 4°.

An investigation of the properties of liquid ethane upon similar lines naturally presented greater difficulties, on account of the further removal of its boiling-point from the ordinary temperature. The pure gas cannot be so conveniently prepared by the method of Köhnlein, as the sealed tubes frequently explode with great force. It was therefore obtained by the well-known method of Gladstone and Tribe from ethyl iodide and the zinc-copper couple. A mixture of ether and solid carbon dioxide is insufficient to effect liquefaction of the gas, but liquid ethylene was found to bring about the necessary reduction of temperature, which latter was measured by means of a copper-silver thermo-element. Liquid ethane in the pure state is perfectly colourless.

The boiling-point of ethane was determined as in the case of propane, the upper part of the apparatus, however, being surrounded by the liquid ethylene instead of solid carbon dioxide. The ethylene was prevented from vapourising rapidly by allowing the extremely cold vapour produced by the evaporation to pass through an outer cylinder, and thus to act as a protective cold bath. The ethane was first cooled by means of ether and solid carbon dioxide before admission into the boiling-point apparatus, after which it was found to be rapidly condensed by the colder ethylene. One end of the thermo-element was immersed in the accumulated liquid instead of a thermometer. The temperature of the liquid when in regular ebullition, produced by removing the cap protecting the lower half of the cylinder, was found to be − 89°·5 at 735 m.m. pressure.

Liquid ethane cannot be sealed in a glass tube without considerable danger. Hence the determinations of vapour pressure and density were effected by the use of a modified Caillétet compressing apparatus and spring manometer. The various temperatures were obtained by surrounding the narrow thick-walled glass tube in which the liquid was produced by suitable baths. The critical temperature at which the curious cloudy appearance was observed, just before the complete disappearance of the liquid meniscus, was found to be 34°·5, and the corresponding critical pressure 50 atmospheres. The meniscus becomes hazy at 32° and only disappears completely at 40°, so that the critical temperature, as in the case of propane, does not appear to be so sharp as with many other liquids of low boiling-point. The following table represents the vapour pressures for a few intervals of temperature.

Temperature.	Pressure in atmospheres.	Temperature.	Pressure in atmospheres.
− 31°	11	0°	23·3
− 20°	14·5	+ 15°	32·3
− 11°	18·3	+ 34°·5	50

Prof. Dewar in 1884 determined the critical temperature and pressure of ethane, and gave them as 35° and 45·2 atmospheres. M. Caillétet had previously stated that at +4° the gas exerted a pressure of 46 atmospheres. Prof. Dewar's numbers are now found to be in close accordance with Dr. Hainlen's results, and the older statement of M. Caillétet must therefore be taken as founded upon an error.

The density of liquid ethane was found to be 0·446 at 0° and 0·396 at + 10°·5.

It may be interesting to compare the facts now established with reference to ethane and propane, with those previously well ascertained for marsh gas and for normal butane.

	Boiling point.	Critical temperature.	Critical pressure.	Density in liquid state.
			atm	
Methane CH_4	−164° (Olszewski)	− 81°·8 (Olszewski)	54·9	0·415 at −164°
	−160 (Wroblewski)	− 95·9 (Dewar)	50	
Ethane C_2H_6	− 89·5 at 735 m.m.	+ 34·5	50	0·446 at 0
Propane C_3H_8	− 37·0 at 760 m.m.	+ 102	48·5	0·536 at 0
n-Butane C_4H_{10}	+ 1	—	—	0·60 at 0 (Ronalds 1865)

If the above boiling-points are represented graphically along with those of the higher normal paraffins, molecular weight or the number of carbon atoms being taken as abscissæ and boiling-point as ordinates, a perfectly regular curve is obtained, slightly concave towards the axis of abscissæ, which very clearly indicates the dependence of the boiling-point upon the molecular weight.

A. E. TUTTON.

THE BRITISH CENTRAL AFRICA PROTECTORATE.

MR. H. H. JOHNSTONE opened the session of the Royal Geographical Society on Monday evening with a paper on British Central Africa, of which he is administrator. He contrasted the condition of the country ten years ago with what it is now, explaining how the Mission schools, the Scottish planters, and the Sikh police had produced changes in the manners, productions, and means of transport of the whole region, and had succeeded in effectually repressing the slave trade. A survey of the Protectorate has been in progress for the last three years, and the map is beginning to acquire some firmness of outline. The great advantage of the Protectorate over the surrounding districts lies in the greater proportion of high land over low swampy country. Roughly speaking, about four-fifths of its land-surface is 3000 feet and upwards above the level of the sea, and about one-fifth is between 5000 and 10,000 feet. The immediate result of this elevation of the land is the prevalence of a much cooler climate than is usually found in Central Africa so near the equator. There are portions of British Central Africa where the heat is never oppressive, even