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 in the hot season, and where in the cold season bitter frosts prevail. Unfortunately, it is impossible to reach this delectable land from the coast without traversing the hot and unhealthy valleys of the Zambezi and Shire.

There is an average rainfall of 55 inches throughout the Protectorate, but it is not altogether uniform in character, some districts receiving about 75 inches, and others not more than 35 inches. Still, it is decidedly a well watered country, endowed with many perennial streams, only a small number of which dry up in the height of the dry season. Consequently, it is a land which can almost everywhere be irrigated during the dry season, and can thus grow a continual succession of crops. The water is almost everywhere wholesome to drink.

The great attraction of the country lies in its beautiful scenery, in its magnificent blue lakes, its tumultuous cascades and cataracts, its grand mountains, its golden plains and dark green forests. A pleasant and peculiar feature also of the western portion of the Protectorate is the rolling grassy downs, almost denuded of trees, covered with short turf, quite healthy, and free from the Tsetse fly; these no doubt will in the future become actual sites of European colonies, districts in which Europeans can rear their children under healthful conditions.

The lofty plateau of Mlanje is a little world in itself, with the exhilarating climate of Northern Europe. These plains and valleys are gay with blue ground-orchids, with a purple iris, and with yellow everlasting flowers. Here and there great rocky boulders stand up in stern relief against the velvet turf, and out of these elevated plains again rise other mountains, gloomy in aspect and remarkably grand in outline. The forests, on closer inspection, turn out to be mainly composed of the handsome conifer *Widdringtonia Whytei*.

No one has succeeded in reaching the highest summit of Mlanje. Mr. Johnston ascended about as far as 9300 feet, and, estimating that there were fully 700 feet more of ascent, approximately fixed the highest point at 10,000 feet. The ascent of this high peak is rendered very difficult by the enormous size of the boulders with which it is strewn. The whole mountain mass of Mlanje probably occupies, with its outlying peaks connected by saddles, an area of 1600 square miles, of which 200 square miles consist of these level or gently undulating plateaux, admirably suited for European settlements. Many of the salient features of Mlanje are repeated in the striking mountains of Nyasaland, with the exception of the cedars, which, however, are reported to exist on one or two of the highest peaks of Zomba, but have never been seen elsewhere.

The low plains surrounding Lake Nyasa and bordering the rivers offer a sharp contrast to the plateaux. Zebras, hartebeests, water-buck, pallah, roan antelopes, and reed-buck may be found in numbers, often dwelling gregariously together on these hot plains; and a few vultures, eagles, kites, and Marabout storks wheel and float overhead in the dazzling bluish-white sky, on the look-out for offal. The sable antelope, the eland, the kudu, and the bush-buck seem to prefer the sparsely forested hill-slopes to the flat plain, where there is usually much less cover. The rhinoceros still ranges over these plains, and wallows in the stagnant pools of the half-dried rivers. The heat prevailing on the plains in the summer-time is very great—almost overpowering—but in the winter and spring the air is exhilarating.

The British settlements have now a settled and comfortable appearance, with uniformed native policemen and trained natives from the Mission schools working as printers and even as telegraph operators at Blantyre. The most interesting feature in the neighbourhood of these settlements at the present time is the coffee-plantation, which, to a great extent, is the cause and support of their prosperity. The variety which is cultivated in the Shire highlands was actually introduced from Scotland, having been derived from a small plant sent from the Edinburgh Botanical Gardens to Blantyre about sixteen years ago. From this plant the greater part of the five million coffee-trees now growing in this part of Africa are descended, while the original mother tree is still alive in the Mission grounds at Blantyre. The climate and soil of Nyasaland would seem to suit the coffee-tree to perfection, and the crops given are unusually large. As yet Nyasaland has been free from the coffee disease, which, as in Brazil and India, does not appear to be able to penetrate far inland from the coast, though it has already committed ravages in German East Africa and in Natal.

EARLY BRITISH RACES.[1]

BEFORE proceeding to trace the early history of man in Britain, it is necessary to refer briefly to the physical changes which geologists tell us have occurred since the close of the Tertiary period in the configuration and temperature of the north-western portion of Europe.

At the beginning of the Pleistocene period, the temperature of Northern Europe became colder, and an ice-cap, like that which now covers Greenland, gradually extended itself probably as far south as Middlesex, and covered the greater part of Wales and the northern half of Ireland. This epoch is known as the Great Ice Age. At that time also the land was more elevated than now, so that Great Britain and Ireland formed part of the continent of Europe, and the western coastline extended some three or four hundred miles further into the Atlantic Ocean than it does at present. This period of cold was succeeded by a more genial one, during which, but before the ice had disappeared, a great submergence of land and of the glaciers still upon it took place, varying at different parts of the country from 600 ft. to over 3000 ft. The climate again became colder, and on the higher parts of Wales, the North of England, and Scotland, glaciers were formed once more, but not to the same extent as formerly. Then followed, in late Pleistocene times, a re-elevation of the land to at least 600 feet above the present level, Great Britain and Ireland once more became joined to the continent, and the climate became temperate. In all probability the geographical conditions of Britain, or rather the British corner of Europe, in early and late Pleistocene times, were almost identical. Finally the land connection with the continent became severed by submergence, which went on till almost the present coast-line was reached; the sea once more rolled in over the beds of the German Ocean and the English Channel. These changes in the geographical conformation of the north-western part of Europe took place slowly, and were consequently spread over an immense interval of time.

According to some eminent geologists, man first took up his abode in the British portion of Europe, either during the early glacial or pre-glacial period. The evidence of his existence here at that early period rests upon the discovery of many flint implements of peculiar and special type on certain high chalk plateaus in Kent in drift resting on Pleiocene beds, in drift deposits of Norfolk and Suffolk, and in certain caves in which glacial drift is believed to be deposited over the flints. All these implements are of the rudest make, more or less stained, like the drift flints with which they are associated, of a deep brown colour. They show a considerable amount of wear, as though they had been rubbed and knocked about a good deal, so that the worked edges are commonly rounded off and blunt. In few instances have the implements been wrought out of larger flints, and the amount of trimming they have received is very slight, and has been generally made on the edges of rude natural flints picked up from old flint drift; indeed, sometimes she work is so slight as to be scarcely apparent; in other specimens it is sufficient to show design and object. These implements indicate the very infancy of art, and are probably the earliest efforts of man to fabricate tools and weapons from other substances than wood or bone. They give us some slight insight into the occupations and surroundings of the race who used them, as they appear to have been employed for breaking bones to extract the marrow, scraping skins, and rounding sticks and bones for use as tools or poles. From the absence of large massive implements, it would seem as though offensive and defensive weapons had not been much needed, either from the absence of large mammalia, or from the habits and character of these early people. Many archæologists are not satisfied with the evidence yet adduced as to the age of these flints, consequently of man's existence in Britain at this early date, and the question cannot be considered settled one way or other.

Whatever may be the ultimate decision as to the existence of pre-glacial man in Britain, all geologists and others are agreed that after the glacial period had passed away, and Britain had once more become a part of the continent of Europe after its submergence, a race of men known to us as Palæolithic man migrated into the country from the continent, across the valley of the English Channel, in late Pleistocene times. Man of this period is known to us from remains found in the river-drifts of

[1] A lecture delivered at the Royal Institution by Dr. J. G. Garson. We are indebted to Prof. Boyd Dawkins for permission to use the accompanying illustrations.