

stant, is greater than $1\frac{1}{3}$; species Q, gases for which k is less than $1\frac{1}{3}$. On looking at the page of NATURE referred to, it will be seen that Perry questioned or even denied the possibility of a gas of species Q. His theorem is:—*A finite spherical globe of gas, given in equilibrium with any arbitrary distribution of temperature having isothermal surfaces spherical, has less heat if the gas is of species P, and more heat if of species Q, than the thermal equivalent of the work which would be done by the mutual gravitational attraction between all its parts, in ideal shrinkage from an infinitely rare distribution of the whole mass to the given condition of density.*

§ 6. From this we see that if a globe of gas Q is given in a state of convective equilibrium, with the requisite heat given to it, no matter how, and left to itself in waveless quiescent ether, it would, through gradual loss of heat, immediately cease to be in equilibrium, and would begin to fall inwards towards its centre, until in the central regions it becomes so dense that it ceases to obey Boyle's law; that is to say, ceases to be a gas. Then, notwithstanding Perry's theorem, it can come to approximate convective equilibrium as a cooling liquid globe surrounded by an atmosphere of its own vapour.

§ 7. But if, after being given as in § 6, heat be properly and sufficiently supplied to the globe of Q-gas at its boundary, and the interior be kept stirred by artificial stirrers, the whole gaseous mass can be brought into the condition of convective equilibrium.

§ 8. In the course of the communication to the Royal Society of Edinburgh, curves were shown representing the distributions of density and temperature in convective equilibrium for four different gases, corresponding to the four values of k :—

Gas (1) $k=1\frac{2}{3}$ (approximately the value of k for the monatomic gases, mercury vapour according to Kundt and Warburg, argon, helium, neon, krypton, and xenon).

Gas (2) $k=1\frac{1}{2}$ (approximately the value of k for seven known diatomic gases, hydrogen, nitrogen, oxygen, carbon monoxide, nitric oxide, hydrochloric acid, hydrogen bromide).

Gas (3) $k=1\frac{1}{3}$ (approximately the value of k for water vapour, chlorine, marsh gas, bromine iodide, chlorine iodide).

Gas (4) $k=1\frac{1}{4}$ (approximately the value of k for sulphur dioxide).

Four of these curves agree practically with curves given by Homer Lane for $k=1\frac{2}{3}$ and $k=1\frac{1}{2}$, in his original paper to the *American Journal of Science*, July, 1870.

§ 9. In a communication to the Edinburgh Royal Society of February, 1887, "On the Equilibrium of a Gas under its own Gravitation only," I indicated a graphical treatment of Lane's problem by successive quadratures, which facilitated the accurate calculation of numerical results, and was worked out fully for the case $k=1\frac{2}{3}$ by Mr. Magnus Maclean, with results shown in a table on p. 117 of the Proceedings of the Royal Society of Edinburgh, vol. xiv., and on p. 292 of the *Phil. Mag.*, March, 1887. The numbers in that table expressing temperature and density are represented by two of the curves now laid before the society. The other curves represent numerical results calculated by Mr. George Green, according to a greatly improved process which he has found, giving the result by step by step calculation without the aid of graphical constructions.

The mathematical interpretation of the solution for Perry's critical case of $k=1\frac{1}{3}$, and for gases of the Q-species, is exceedingly interesting.

The communication included also fully worked out examples of the general solution of Lane's problem

for gases of class P of different total quantities and of different specific densities.

§ 10. In my communication to the Royal Society of Edinburgh, of February, 1887, I pointed out that Homer Lane's problem gives no approximation to the present condition of the sun, because of his great average density (1.4). This was emphasised by Prof. Perry in the seventh paragraph, headed "Gaseous Stars," of his letter to Sir Norman Lockyer on "The Life of a Star" (NATURE, July 13, 1899), which contains the following sentence:—

"It seems to me that speculation on this basis of perfectly gaseous stuff ought to cease when the density of the gas at the centre of the star approaches 0.1 or one-tenth of the density of ordinary water in the laboratory."
KELVIN.

THE PROBLEM OF THE RHODESIAN RUINS.¹

THE recent investigation of some of the famous ruins of Rhodesia, conducted in 1905 by Dr. D. Randall-MacIver on behalf of the British Association and the Rhodes trustees, has resulted in an entirely fresh view of their origin and age. The hitherto generally accepted view, that these buildings were erected in very ancient days by a Semitic people, whose search for gold led them thus far afield, has received a serious check. Dr. MacIver's researches, conducted upon the lines of archæological investigation, point to the buildings in question being of comparatively recent date, not earlier, in fact, than late mediæval times. This result is the more striking when we remember that his previous researches have been mainly archæological, conducted chiefly in Egypt, and that, in consequence, we might expect a certain degree of bias in favour of retaining the ruins within the sphere of archæology. That a trained archæologist has been unable to find evidence of high antiquity upon the sites investigated is at least a strong point in favour of his argument.

Dr. MacIver made excavations on seven sites in various parts of Rhodesia, these being:—(1) Inyanga, on the Cecil Rhodes estate, sixty miles north of Umtali; (2) the Niekerk ruins to the north-west of Inyanga; (3) a site three miles south of Umtali; (4) Dhlo Dhlo, in the Incisa district; (5) Nanatali, sixteen miles east of Dhlo Dhlo; (6) Kami, fourteen miles west of Bulawayo; and (7) Great Zimbabwe, in the Victoria district, the site which hitherto had received the greatest attention. These sites were well selected as being distributed over a wide area, and, moreover, as differing considerably from one another both in general character and in special features, as also in the greater or less degree of elaborateness in their structure. It may be remarked at once that the distinctive features observable in comparing the different buildings are often no less remarkable than are the points of similarity. No two seem to be alike, and the divergences and specialisation render their individuality very striking.

The principal questions to be determined in regard to these remarkable buildings were: By what people and at what period were they erected? The controversy, which is still active, centres mainly upon these two main points, and the older theory of their Semitic origin and great antiquity, urged by Mauch, Bent, Keane, Hall, and others, is being maintained steadfastly and strenuously by several authorities. Dr. MacIver in the title of his book, "Mediæval Rhodesia," has hoisted his fighting flag. His conten-

¹ "Mediæval Rhodesia." By Dr. David Randall-MacIver. Pp. xv+106. (London: Macmillan and Co., Ltd., 1906. Price 20s. net.

tion is that none of these buildings are referable to an earlier period than mediæval or post-mediæval times. He argues that none of the objects hitherto discovered in excavating within the area of the ruins would be recognised by an archæologist as "more than a few centuries old; and that the objects, when not immediately recognisable as mediæval imports, are of characteristically African type." Inyanga and the Niekerk ruins do not appear to have produced any but native African objects, and at Umtali a fragment of glazed stoneware was the only foreign object found. At the better-known sites, Dhlo Dhlo, Kami, Nanatali, and Zimbabwe, a fair number of imported objects have been found, but here again Dr. MacIver holds that in no case is there evidence of a pre-mediæval antiquity. As far as possible, he endeavoured in his excavations to reach the lowest strata, and to explore the levels which must be contemporary with the earliest portions of the walls of the buildings, and the objects found therein were naturally considered by him of the highest importance.

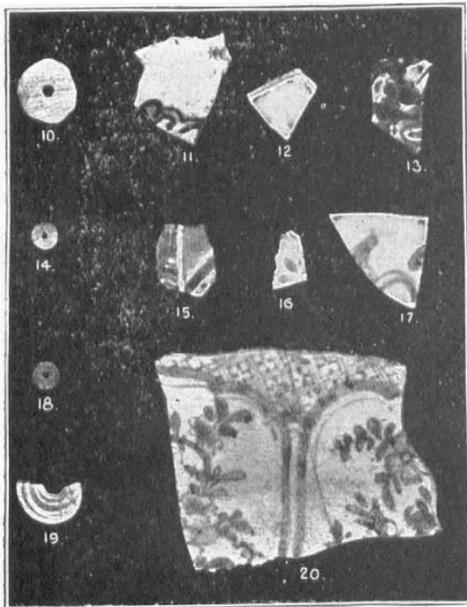


FIG. 1.—China and Ivory and Shell Reads found at Dhlo-Dhlo. From "Mediæval Rhodesia."

It was at Dhlo Dhlo that he discovered his most valuable piece of evidence. The absence of objects of foreign workmanship and of known date at the Inyanga, Niekerk, and Umtali sites rendered impossible the assignment of any definite period to the buildings there, although the negative evidence may be held to indicate the lack of foreign influence, which itself may possibly be regarded as pointing to these sites being earlier than the others which were examined, a view which is held by the author on structural grounds. At Dhlo Dhlo, on the other hand, numerous imported objects were found, and in excavating one of the platforms upon which a dwelling had been erected, and which Dr. MacIver asserts most positively is contemporaneous with the earliest portion of the building, he came across a piece of blue and white Nankin china in the unbroken cement floor of the dwelling. This fragment is shown (No. 20) in the illustration reproduced. If this cement floor was, as he maintains, erected at the same time

as the oldest walls of the main building, we must certainly admit the validity of his contention that the building cannot antedate the fragment of porcelain, and that the date of erection, therefore, cannot be pushed back beyond late mediæval times. His critics appear willing to admit the validity of his argument as regards Dhlo Dhlo, but they urge that the buildings on this site are relatively late, and that this dating will not hold good in the case of the buildings at Great Zimbabwe, which they regard as much earlier.

Dr. MacIver regards the principal buildings, such as the so-called "Elliptical Temple" at Zimbabwe, as being fortress-kraals, and urges that the "Elliptical Temple" itself was the fortified residence of the Great Chief, or Monomotapa, whose sway extended over an enormous area and a very extensive population. To understand how architectural feats, such as the finer Rhodesian buildings at Dhlo Dhlo, Nanatali, and Zimbabwe, can have been achieved by the precursors of the modern South African natives, it is necessary to assume that in those days there was organisation of a far higher character than has obtained in recent years, organisation under great chiefs whose power and intelligence were of a relatively high order. This would appear, from the Portuguese and other records, to have been the case in the days of the Monomotapan empire of the Middle Ages down to the close of the sixteenth century. The Monomotapa, or paramount chief, may well have resided at Zimbabwe, and he is recorded to have had captains in various fortresses elsewhere. The organisation of labour implied by the elaborate and decorated stone architecture is certainly remarkable, more particularly when we compare these edifices with the results of the constructional efforts of the modern Kafir peoples; but under an intelligent and powerful ruler, and under stable conditions of life, a degree of culture may have been reached far higher than it is possible for smaller communities under lesser chiefs to maintain. It seems well within the bounds of probability that under such conditions even the finer buildings may have been erected by the more progressive and united precursors of the present native inhabitants of Rhodesia.

Even more remarkable, in some respects, than the huge "fortified kraals" are the terrace walls on the Niekerk site described by Dr. MacIver. These stone-built walls form irregular concentric rings round the hills upon which the villages were situated, and although structurally simple, cover an enormous area extending in close formation over a space of upwards of fifty square miles. They do not appear to have been erected as supporting walls for agricultural terraces, nor to have been connected with an irrigation system, and, in the absence of evidence to the contrary, one must assume that their purpose was defence, though one accepts this view somewhat reluctantly, for, when regarded as an elaborate system of defensive girdle walls, one cannot but admit that their practical value is hardly commensurate with the enormous labour expended upon them. They recall to one's mind the *sementera* walls of Luzon, in the Philippines, which also form long, irregular, though concentric alignments up the slopes of the hills, following their contours, covering, too, a very large extent of country. In the case of the *sementeras* there are transverse walls dividing up the terraces into sections. They are purely for agricultural purposes, and are mostly, though not all, connected with a wonderful system of irrigation. It might be of use to compare the *sementera* system with the Niekerk terrace walls, on the chance of a clue to the

latter being found, and it is to be hoped that an accurate survey may eventually be made. The scientific study of the ruins is still in its infancy, and a vast amount of work remains to be done. As has been said, there are two distinct and antagonistic theories of their origin. It is eminently to be desired that the Rhodesian authorities will in every way encourage, nay, promote, further detailed excavations by trained men of science. Such a work would redound greatly to the credit of Rhodesia, and would be followed with the greatest interest throughout the scientific world. It would imply the exploitation of

It has been urged that the ruins have been shorn by Dr. MacIver of their romance. Taking the term romance in its strict sense, this may be true. For legendary uncertainty he has sought to substitute scientific fact. For ill-defined Semitic invaders he offers a native indigenous people; and King Solomon and the Queen of Sheba he replaces with the Monomotapa. How far he is justified will be shown by future investigations. At least he has presented his case in a straightforward and lucid manner in a very attractive and well-illustrated book, and it does not appear that the problem is in any way less fascinating

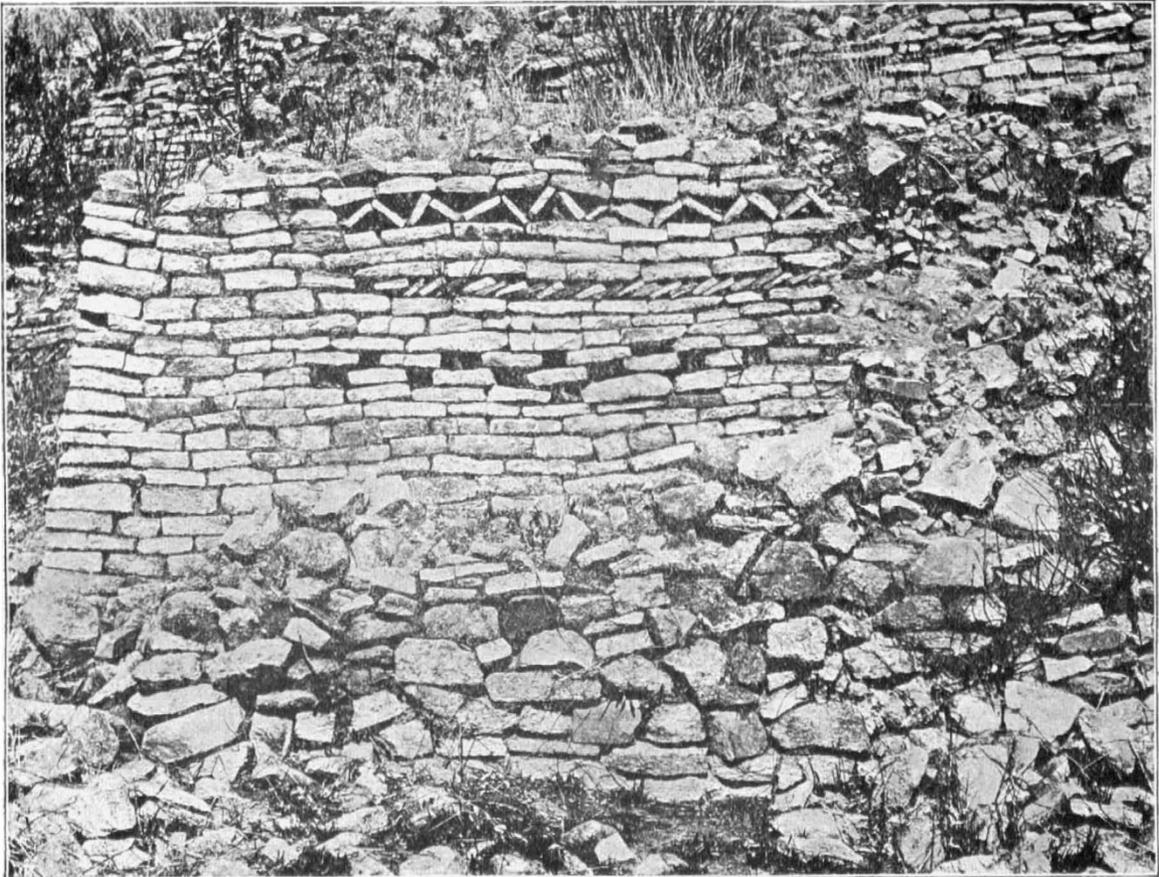


FIG. 2.—Decoration of West Side of Main Entrance, Dhlo-Dhlo. From "Mediaeval Rhodesia."

one of the most valuable scientific assets of the country. Dr. MacIver makes out a strong case, but it is desirable to know more precisely to what group of Bantu peoples the buildings are assignable. Whence came they? Many of the native objects found are identical with those in use by the modern Kafir peoples; others, on the other hand, show affinities with a north-western culture, and appear almost out of place where found. Then again, the older gold mines themselves have hardly been examined at all in detail. They should yield material of importance. It is further desirable to explain more fully the individuality of the different settlements and of the arts of their former inhabitants, to diagnose, for instance, the presence of very numerous stone carvings at the Umtali ruin, excavated by Captain E. M. Andrews, in the light of their prevailing absence elsewhere.

or less worthy of accurate study for having, perhaps, been transferred from the province of archæology to that of ethnology.

PROF. D. I. MENDELÉEFF.

DEATH has been very busy of late among the army of men of science, and nowhere has he been more active than in Russia, where within the space of a few weeks three of that country's foremost chemical philosophers—Beilstein, Mendeléeff, and Menshutkin—all men of front rank and of a world-wide reputation, have submitted themselves to the strict arrest of the fell sergeant. An occurrence of like character and extent is almost unknown in the annals of science. The nearest approach to it is in our own history, when within an interval hardly greater we lost Wollaston, Young, and Davy.