nurse-cells; the resting egg arises from a modified group of four cells, which absorbs numerous other four-celled groups. The author confirms Weismann's statements that the origin of resting eggs is not connected with any influence of the male, that these eggs do not enter the brood pouch, but if not fertilised degenerate in the ovary, that the carapace of Daphnia changes into an ephippium only if the ovary is forming resting eggs, and that these eggs invariably give rise to females.

(6) The Donaciinæ, a sub-family of the Chrysomelidæ (leaf-beetles), are of special interest on account of certain peculiar features in the habitat and mode of life of the larvæ, which are fully described and illustrated in Dr. Böving's memoir, which also contains an exhaustive account of the larval anatomy. The author concludes that the features hitherto utilised to differentiate the larvæ of Hæmonia and Donacia are unserviceable; it has, in fact, not been possible to find real generic distinctions between the larvæ, although the adults present well-marked differences. Conversely, though the adults of Donacia and Plateumaris have been found to exhibit only small differences, from which it might have been expected that the larvæ would be difficult to distinguish, it is shown that the larvæ of Plateumaris, here described for the first time, are dissimilar from those of all other Donaciinæ. The larvæ gnaw the roots of certain aquatic plants (Potamogeton, Sparganum, Carex, &c.), and while doing so arrange the head and prothorax so that the latter forms with the plant a water-tight compartment in which the head can work undisturbed by, and the food be kept from admixture with, water and dirt. The mandibles of the larva have a cutting, and not a crushing, edge; they cannot be used for grinding, and, in fact, serve only to make an entry into the plant tissue, the sap of which then exudes and is received by the laciniæ of the maxillæ and passed backwards into the gut. The larvæ seem to feed exclusively on the sap; an examination of the gut contents, which consist of a homogeneous yellow fluid, shows that cell-fragments are not present. The external features of the head, the mouth parts, the muscles, and the mechanism of feeding are considered in great detail.

Aquatic insects have adopted various devices for obtaining a sufficient supply of air; the larvæ of the Donaciinæ have chosen a very remarkable one, namely, to tap the reservoirs of air in the intercellular spaces of the submerged parts of plants. At the posterior end of the abdomen is the "abdominal organ," which the author shows to be a bifore spiracle. The terminal hook of this organ is plunged into the vegetable tissue, air passes from the latter into the organ, and apparently through thin membranes into an atrium, which leads into the main trachea. The spiracular slit in the abdominal organ serves for expiration.

The making of the cocoon is described at length. The outer envelope is formed by a secretion of the whole body, and is lined with a substance produced in four large œsophageal glands; the larva gnaws one or two holes through the bottom of the finished cocoon so as to make connection with the air spaces of the root to which it is attached; air is thus secured for the pupal stage. The author gives a list of the food plants of the different species of larvæ of this family found in Denmark, and accounts of the gnawings, the sizes of the larvæ at different periods, the length of larval life, hibernation, the flying period of the adults, the eggs, and the post-embryonic development. The memoir forms a substantial addition to our knowledge of the anatomy, biology, and development of these interesting larvæ.

J. H. A.

PHYSICAL ANTHROPOLOGY OF AUSTRALASIAN RACES.

IN the Proceedings of the Royal Society of Edinburgh for the present session (1910–11) appears a series of four papers devoted to the physical anthropology of the races of Australasia. The papers are by three authors, two of them human anatomists, Prof. R. J. Berry and Dr. A. W. W. Robertson, the third a mathematician, Mr. K. Stuart Cross. The authors seek to fix the position of the Tasmanian and Australian natives amongst present and past races of mankind by applying biometrical methods to certain measurements of the skull.

The most valuable paper of the series is that by Dr. Robertson, where he gives the data obtained from measurements of 100 Australian crania. By applying Prof. Karl Pearson's test for purity of race, Dr. Robertson finds the native Australians are "pure" when the measurements of the width of the cranium is considered, but "impure" when the lengths are investigated. It will be seen that Dr. Robertson's results are somewhat equivocal, and may be quoted in support of either the unity or duality of the Australian race. Similar methods applied to the Tasmanian race show a much higher degree of homogeneity or purity. The difference in purity between the Australian and Tasmanian races may be explained by the fact that one is spread over a large continent, while the other is confined to a small island.

An attempt is also made by the authors to fix the position of the much-discussed Tasmanian race in the scale of human evolution. The result will somewhat surprise those who have sought to establish racial relationships on an analysis and comparison of mere anatomical characters, for by the methods here employed the Dschagga negro comes out as the advance guard of the human race, well in front of the European, while the native Tasmanian gains a good place, being sandwiched between two ancient Europeans—the man of Brünn and the Cro-magnon race.

From an anatomical point of view the results are surprising, for it would be hard to find greater cranial contrasts than those between the Tasmanian and Cro-magnon on one hand, and the Tasmanian and Brünn on the other. There can be no doubt, however, as to the high value of the new data with which these papers supply anthropologists.

THE PRODUCTION AND IDENTIFICATION OF ARTIFICIAL GEMS.[1]

I PROPOSE to limit the term "artificial" to such productions as possess the same chemical composition and physical constants as the natural stones, differing from them only in minute details consequent upon their being produced in the laboratory instead of being dug out of the earth, all other makeshifts being properly described as "imitations."

The scientific examination and identification of gems is a matter of the greatest interest, but it would take far too much time to discuss it in detail; and it is quite unnecessary to do so, because it has already been brought before the society most exhaustively by our chairman, Dr. Miers.[2] I propose, therefore, merely to remind you of the main points.

In order to bring this matter up to date, however, I must refer briefly to one or two particulars in which advance has been made since the time of these lectures.

The most important properties of a precious stone are those depending upon its refractive powers. Until recently, the accurate determination of the refractive index of a stone was a matter involving the use of complicated and expensive instruments, and a matter for the skilled mineralogist rather than the practical jeweller. It is true that at the time Dr. Miers published his lectures there existed an instrument known as the reflectometer, but the determination of the refractive index with this was a matter of some difficulty even in skilled hands, and its value for commercial purposes was very small. Since that time, however, thanks to the ingenuity of Dr. Herbert Smith, this instrument has been improved out of all recognition, and in its place we have the Herbert Smith refractometer (Fig. 1), by means of which anyone of normal common sense can determine the refractive index of a stone in a few seconds without even removing it from its setting, and which, with a little practice, will also enable one to determine with similar ease the amount and kind of double refraction and the degree of dispersion.

Taking the properties of precious stones as a whole, the great point about them is the remarkable combination of qualities; it is not so much that they have optical

[1] Abstract of a paper read before the Royal Society of Arts on April 26, 1911, by Noel Heaton.

[2] Cantor Lectures on Precious Stones, April, 1896.

properties which make them extraordinarily beautiful, or that they have remarkable hardness and durability, but they have *both*, and it is the impossibility of reproducing this combination in any other material that renders the detection of imitations a matter of ease in the hands of anyone familiar with the facts.

The most important point to remember about paste is its lack of durability; it is not only too soft to stand much wear, but its composition is so unstable that it rapidly deteriorates and loses its brilliancy on exposure. You will see, therefore, that although there is a certain legitimate scope for such paste imitations, they are very unsatisfactory substitutes for the genuine article. This being the case, as scientific knowledge has advanced, attention has been more and more concentrated on the problem of producing by artificial means the actual minerals found in nature, and thus obtaining what I have defined as artificial in contradistinction to imitation jewels, having both the beauty and durability of the natural article without the objectional concomitant of enormous cost.

The first point to be considered in attacking this problem is the composition of the stone, as it is obvious that, other things being equal, the possibilities of success are greater with a stone of simple than one of comparatively complicated composition. The economic aspect has also to be considered—it is not much use devoting time and ingenuity to the production of an artificial stone when the natural one is so common that the cost of the two would be practically identical.

Commercially, we are as far from being able to produce artificial diamonds as in the days of the alchemists. It is,

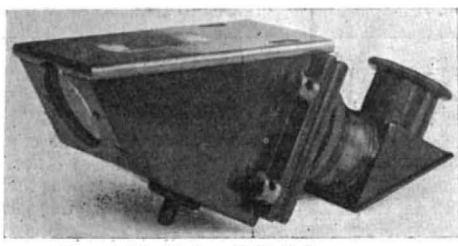

FIG. 1.—The Herbert Smith Refractometer.

perhaps, a bold thing to say that no such thing as an artificial diamond will ever be placed on the market, but one can safely assert that, so far as our knowledge stands at present, it is impracticable. In saying this, I am quite aware that statements as to the commercial production of synthetic diamonds being an accomplished fact have quite recently appeared broadcast in the public Press, but those who are responsible for such statements are (shall we say?) under a misapprehension as to the meaning generally conveyed by the term "synthetic," and are unable to follow the distinction I have drawn between an artificial gem and an imitation.

The chief problem to be faced is that of attaining the necessary temperature, and it is not surprising that crystalline alumina was produced as a scientific curiosity so far back as the commencement of the nineteenth century. It is at this time that we first begin to hear of the oxy-hydrogen blow-pipe (or the gas blow-pipe, as it was then called). The process of producing reconstructed rubies by means of the oxy-hydrogen blow-pipe is, roughly, as follows:—The residue from cutting rubies and small worthless stones is broken into coarse sand, a small quantity of which is placed on the centre of a disc of platinum; this is then carefully brought to the fusion point, care being taken at this stage not to raise the temperature to such an extent as to melt the platinum support. So soon as this mass is fused it serves to protect the platinum, and the reconstructed ruby can be built up on it by adding the fragments of ruby one at a time by means of small platinum forceps. These pieces have to be dropped on with great care in order to secure incorporation with the mass and prevent, so far as possible, the formation of air bubbles. It will be readily understood that this process is a tedious and laborious one, and, in fact, the formation of masses of sufficient size to yield large stones on cutting is a matter of such difficulty that the cost of production is very high.

Just about seven years ago, however, Verneuil[1] overcame this restriction when he hit on the extremely ingenious idea of introducing the raw material through the blow-pipe, and thus placing it on the support automatically. The blow-pipe is arranged vertically over a small insulated chamber containing the support on which the mass is to be built up. The oxygen tube communicates at its upper extremity with a funnel-shaped hopper, in which is suspended a small sieve filled with the raw material, which is rhythmically shaken by means of a small hammer actuated by an electromagnet or cam. Each time the hammer taps the support of the sieve, causing it to vibrate, a small quantity of the powder falls through into the tube below, and, carried along by the gas, passes out at its lower extremity into the zone of flame, where it is immediately raised to the fusion point, and falls as a melted globule on to the support below.

This support is arranged with a screw adjustment, so that as the mass of corundum is gradually built up by the constant addition of fresh globules the surface can be kept at a constant level, and the portion already formed removed from the zone of heating so as to allow it to stiffen. When the apparatus is first started the blow-

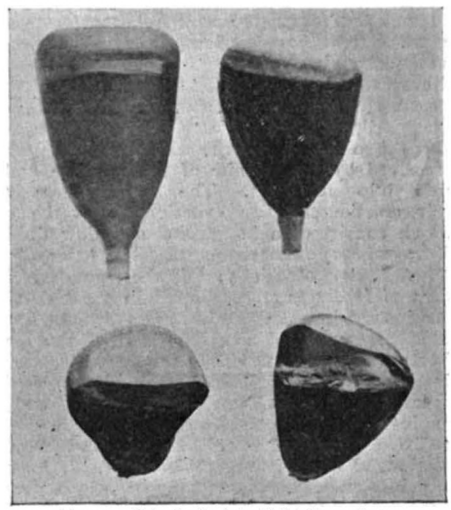

FIG. 2.—"Boules" of Artificial Corundum.

pipe is adjusted so as to give a comparatively cool flame, and the powder is admitted slowly. By this means a small "stalk" is formed, which insulates the mass from the support and prevents the fusion of the latter. When this has been formed, the full pressure of the blow-pipe is put on, and the rate of admission increased, with the consequent formation of a "boule," as it is termed, having the shape of a pear, as illustrated in Fig. 2.

With this apparatus a boule weighing some twenty to thirty carats, and capable of yielding two cut stones of about six carats each, can be prepared in about half an hour almost automatically, a single operator being able to control several machines.

The "synthetic" corundum produced in this way, if pure ammonium alum is used, is, of course, colourless, and can be used as artificial white sapphire. If a small proportion of chrome alum is added, the resulting stones are rubies, and other colours may be produced in the same way. For a long time all attempts to reproduce the fine blue of the sapphire failed. A year or so ago, however, the problem of producing synthetic sapphire was finally solved by the use of titanium oxide, a very unexpected result considering the chemical position of this element. The artificial production of the corundum gem-stone may be considered to be completely solved, and cut stones can now be obtained in every variety of colour, from pure

1 "Mémoire sur la reproduction artificielle du rubis par fusion," M. A Verneuil, *Annales de Chimie et de Physique*, September, 1904.

white to ruby and sapphire, at prices ranging from four to ten shillings a carat, according to colour, quality, and size.

Whatever may be their economic importance, a very much debated question, there can be no doubt as to the scientific interest of this group of artificial gems. In the first place, it is a matter of some interest that a mass of fused material formed in this way should not only be crystalline, but possess all the characteristics of a single crystal. Crystallographers are agreed that each boule is a single crystalline individual, with the axis roughly perpendicular to the plane of formation—that is to say, running from the point of attachment of the pedestal to the top of the mass.

Then there is the matter of coloration. One would like very much to know what is the state of combination of the chromium in a ruby, and whether the colour is produced by chromium aluminate in solution or metallic chromium in molecular suspension.

A point of more practical interest is the fact that although the artificial corundum is a true crystal, it possesses the shape and formation of a congealed liquid or glass. The practical interest of this lies in the fact that it affords the only means of distinction between this artificial corundum and the naturally formed gem-stone. Being of exactly the same composition and crystalline structure as the natural mineral, it cannot be identified by any of the physical tests I briefly referred to above. For all practical purposes, the artificial ruby *is a ruby*, and one can only deny that it is a "genuine ruby" if this

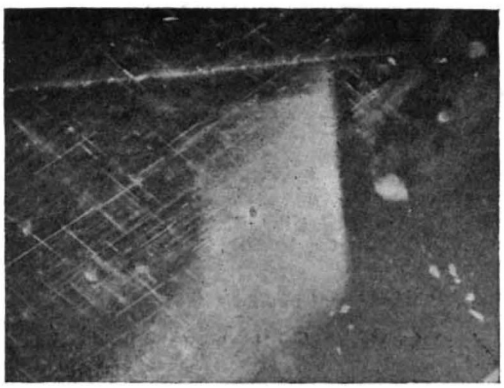

FIG. 3.—Section of Natural Ruby, ×100.

word is held to connote essentially a product found in the earth and not made by man.

And yet, owing to the curious anomaly of its structure, the artificial product can almost invariably be distinguished from the natural with the greatest ease. In the naturally formed stone any foreign matter which may be present is coerced into following the lines of growth of the crystal, and more particularly bubbles of gas which may be present in the liquid are distorted from their natural shape so as to accord with this symmetrical growth. It is the great exception to find a natural ruby entirely free from such inclusions, which generally form irregular cavities with a decided tendency to geometrical shape.

In the great majority of cases examination of the cut stone with a lens is sufficient to decide the artificial process of formation, but in doubtful cases a more minute examination may be made by placing the stone in a little cell filled with highly refracting liquid, in order to secure regular illumination, and examining it under the microscope by transmitted light, when the minutest trace of structure can be detected. In the case of an absolutely flawless stone it would be impossible to decide whether it were natural or artificial, but such stones are so rare that this case is almost theoretical.

Reconstructed emeralds have been made by the Verneuil process, but these are, of course, amorphous, and do not possess the double refraction and other properties consequent upon the crystalline structure of the natural stone. The problem of producing this stone artificially has not as yet been solved.

The opal ranks with the diamond in resisting attempts at artificial production, and is even superior to it in that it cannot be really successfully imitated.

The peculiar lustre of the pearl, like the colour of the opal, is due rather to its structure than its composition. It is formed in the oyster by the deposition of successive layers of calcium carbonate round some central object, and consists of an innumerable number of thin overlapping laminæ of the crystalline variety of this substance known as aragonite. These layers being semi-transparent, the light falling on the surface is partially reflected from the surface and partially transmitted into the stone, where it suffers reflection from the surface of lower layers.

Perhaps the well-known Japanese pearl may be correctly described as artificial pearl, although the oyster has a great deal to do with it.

Such pearls are formed by introducing a mother-of-pearl shape between the shell and mantle of the oyster, and then leaving the oyster alone for a time to allow it to convert this into a pearl by the deposition of several layers of nacre. The mass is then removed from the shell and converted into the semblance of a true pearl by supplying a back of mother-of-pearl. Such pearls, however, never have the fine orient of those produced under normal conditions, and they can readily be detected by examining the back, when the lustreless mother-of-pearl and the line of junction can be detected.

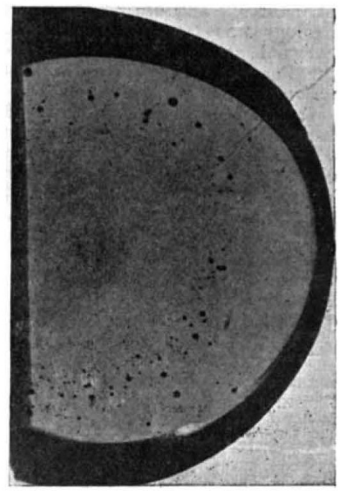

FIG. 4.—Section of Artificial Ruby, ×10.

Nobody has any right to supply anyone with paste under the name of artificial (or synthetic, or scientific, if these names are preferred) gem. I think that the distinction between the two should be clearly recognised, and that it should not be permitted to use the term artificial indiscriminately. At present this is being widely practised; every day one sees offered for sale "rubies, emeralds, sapphires, and pearls artificially produced, and having all the properties of the natural stone." Now, as I have indicated, such a thing as an artificial emerald answering this description is unknown, and, as a matter of fact, the stones supplied under this title are, as a rule, nothing more or less than paste imitations, the public being deliberately led to believe otherwise. There is in this case, as I have indicated, a real practical difference between the two articles, not merely a question of opinion.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—In the faculty of medicine an important change in the organisation of clinical teaching is being made. Hitherto this branch of teaching has been quite outside the control of the University. A clinical board appointed by the staffs of the Queen's and General Hospitals has directed the teaching and collected and administered the fees of students. In future the clinical board is to consist of nine members, of whom five will be appointed by the University and four by the two hospitals. The board will arrange all details of clinical teaching, and will nominate to the council of the University persons in the hospitals to act as clinical teachers, who will become members of the University staff. The fees for this teaching will be paid to and administered by the University. In consequence of the new arrangement, medical studies will be recognised by the Board of Education as a "technical" subject, in