

many investigators in the paths of natural science who may find some difficulty in realising the physical basis and real bearings of the theory, and who nevertheless take a rational interest in the solution it is capable of affording to some of the greatest difficulties of molecular physics. The whole structure of physics may be said to rest upon a *molecular* basis, and therefore the importance of a right view of this basis cannot be over-estimated. The old theory of *perfectly rigid* molecules put an immense difficulty in the way of the development of physical results upon such a groundwork. A theory of *elastic* molecules therefore becomes of the utmost importance as a practical working hypothesis, and the accordance with observation of new results predicted from this hypothesis as a basis, will then form additional confirming illustrations of its truth. The removal of any misunderstandings that might be obstacles in the way of the use of the vortex-atom theory as a working hypothesis becomes, therefore, a point of considerable importance. Those more especially who have handled the spectroscopy and viewed the exquisite precision of its results, become impressed with the *certainty* of the groundwork upon which their molecular studies are based, and no less imbued with the conviction of the existence of that *explanation* that forms the basis of the facts that are recorded with such unflinching accuracy.

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COMPARATIVE ANATOMY OF MAN¹

I.

THE great scope and interest of the subject of anthropology, as well as its most convenient subdivisions, are well illustrated by the prospectus of the teaching at the Anthropological Institute of Paris. There are at present six chairs:—(1) Comparative Anatomy in Relation to Anthropology, by Broca; (2) Biological Anthropology, or the Application of Anatomy and Physiology to Anthropology, by Topinard; (3) Ethnology, or the Study of the Races of Man, by Dally; (4) Linguistic Anthropology, by Hovelacque; (5) Palæontological and Prehistoric Anthropology, by Mortillet; and (6) Demography, which includes what we commonly call social and vital statistics and Medical Anthropology, by Bertillon. These subjects are publicly taught in a school supplied with all necessary appliances, founded partly by private munificence, but also liberally subsidised by the Municipality of Paris and the Department of the Seine. There is also at Paris a complete course of general anthropology given yearly by M. de Quatrefages in connection with the magnificent museum at the Jardin des Plantes. To these institutions we have nothing comparable in England, and neither at our Universities or elsewhere is any branch of anthropological science systematically taught. The present lectures only embrace a small portion of one of the six subdivisions enumerated above, that of biological anthropology. This science is purely one of observation, and in proportion as the materials upon which our observations are founded are multiplied, so will the value of the observations be increased. These materials are collected in museums, which at present in this country are not so complete as might be desired. The largest public collection is that of the College of Surgeons, containing about 1,200 crania of different races; the largest private collection is that of Dr. Barnard Davis, of Shelton in Staffordshire, considerably exceeding that of the College both in number and variety of specimens. Happily these are about to be united, and, under the care of the Council of the College, will be made accessible to all who wish to pursue the study of anatomical anthropology.

¹ An article on "The Atomic Theory of Lucretius," *North British Review*, March, 1868, also by Prof. Tait, in his work "Lectures on Some Recent Advances in Physical Science."

² Abstract Report of Prof. Flower's lectures at the Royal College of Surgeons, March 1 to March 19, on the Comparative Anatomy of Man.

Besides the Barnard Davis collection, only a small portion of which has as yet been received, one of the most important additions to the museum since the last course of lectures is a series of skulls collected in the Fiji Islands in 1876 by Baron Anatole von Hügel, forming part of a donation made by Mr. Erasmus Wilson. They consist of sixteen crania of the *Kai Colos*, or mountaineers of the interior of the western portion of Viti Levu, and five crania from the eastern coast and small islands adjacent. The inhabitants of the Fiji group are generally described by ethnologists as a mixed race, compounded of Melanesians and of brown Polynesians, as the islands are situated on the confines of the territories inhabited mainly by these two races, and the few crania hitherto accessible have favoured this view. Those, however, of the Kai Colos brought home by Baron von Hügel, and which probably represent the most primitive native population of the islands, show all the characters of the purest Melanesian type, without the slightest trace of Polynesian mixture. Their purity is shown by their wonderful similarity, and by their very peculiar and strongly-marked characters, discernible with equal facility in both sexes and at all ages. They are large, the average capacity of eight adult males being 1,482 cubic centimetres; and with muscular ridges and impressions strongly developed. In proportion to their length, they are the narrowest crania known, having an average latitudinal index of only 66.3. Not one has the index so high as 70.0, and in one it descends as low as 61.9, which is below that of any other normal skull in the collection. The height in all very considerably exceeds the breadth, the average altitudinal index being 74.1. They thus belong to the most strongly marked *hypsi-stenocephalic* type. The zygomatic arches are very wide compared with the cranium. The brow ridges are strongly marked, though less so than in the Australians. The orbits are low and quadrangular, the nasal bones short, though rather prominent, and the nasal aperture wide (index 57.1), the jaws prognathous, though not to an extreme degree, and the teeth large. The skeleton of the face thus conforms with what is generally found in the Melanesians or Oceanic negroes, but the features are on a larger scale and more strongly pronounced than in the inhabitants of many of the New Hebridean and Papuan islands. The skull of the Tongans and Samoans, living on islands scarcely 300 miles from the Fijis, presents the greatest possible contrast to that just described. It is short and round (latitudinal index 82.6), the orbits are round, the nasal bones long and flat, and the aperture narrow (index 44.3), and the jaws are not prognathous. It is well known that for a long time the Tongans have been in the habit of visiting the Fijis, especially the smaller islands to the east of the group, and that there is in the inhabitants of that region a considerable infusion of Tongan blood. Five skulls of natives of the small island of Vanua Balavu, where this influence is supposed to prevail, show a distinct deviation in every character from that of the Kai Colos, and these deviations are, without exception, in the direction of the Tongan or Polynesian type. The average latitudinal index is raised to 71.9; the nasal index is 50.0, the orbits intermediate in form, and the prognathism much reduced. No skulls have as yet been examined from the second large island, Vanua Levu, and the numbers of those just described are, perhaps, not sufficient to draw any great conclusions from, but, as far as they go, they tend to show that, so far from the Fijians generally being a mixed race, the mass of those that inhabit the interior of the large islands are remarkably pure, and of the Melanesian or Papuan type in its most characteristic, almost exaggerated, form, but that the natives of the coast districts and outlying islands to the east show certain tendencies towards the brown Polynesian type, and as these are the people with whom European visitors to the Fijis have mostly come

into contact, an undue impression has been created as to the extent of the mingling of the races. At all events, little countenance is given by these facts to the view, which rests chiefly in the interpretation of some ancient legends, that at a former time the Tongan influence was much greater in the Fiji Islands than it is at present.

Races of America.—Two extreme views have been held as to the unity or diversity of the races of man inhabiting the American continent. It has been said on the one hand that "when you have seen one Indian you have seen all," and on the other, that as much difference can be found in the native Americans, as among the inhabitants of the Old World. Both statements are exaggerations, the truth lying between the two. A source of difficulty in studying the cranial conformation of the Americans lies in the wide-spread practice of deforming the head artificially in infancy. This habit prevailed extensively but not uniformly throughout all the western parts of the continent, from Vancouver's Island down to the southern parts of Peru. It also occurred, though less generally, in the southern part of what is now the United States, and in the West India Islands. It was forbidden to the Peruvians in 1585 by the synod of Lima, and again with severe penalties in 1752. In British Columbia it has only recently fallen into disuse. The custom is, or perhaps we may almost say was, not confined to America. Hippocrates and various other writers of his age, speak of the *Macrocephali*, people who dwelt on the eastern shores of the Black Sea, who purposely altered the form of their children's heads. Skulls thus deformed have been found in ancient tombs in the Caucasus (especially near Tiflis) in the Crimea, and, though less numerous, at various places, along the course of the Danube, and extending as far as the south of France. These have been assigned to Avars, Huns, or Tartars, but more probably belong to the Cimmericians, who originally inhabited the region where they are now found most abundantly, and spread westward over Europe some centuries before the Christian era. The custom, though in a modified degree, is scarcely yet extinct in the south of France. Cranial deformation, though usually only of the simple occipital form, is also practised in many parts of Asia and Polynesia, though quite unknown in Africa or Australia.

Many attempts have been made to classify the various kinds of cranial deformation, but as they pass insensibly into one another, it is not very easy to do so. They may, however, for convenience of description be grouped thus: 1. Simple occipital flattening, often probably undesigned, being occasioned by the pressure of the board or hard pillow upon which the child is laid; this is very common among the ancient Peruvians and also among some Mongol tribes and Polynesians. 2. Simple frontal flattening, also common in Peru, though less so than some of the following forms; also among the Caribs and in the island of Mallicollo, in the new Hebrides. 3. Fronto-occipital flattening, with lateral (compensatory) expansion, usually unsymmetrical. This, which may be depressed or elevated according to the point at which the greatest occipital pressure is applied, is the commonest form among the Indians of British Columbia and Vancouver's Island, and is also met with in Peru. The head is compressed between pads of birch bark and moss from birth to the age of twelve months. During subsequent growth it recovers somewhat from the extremely flattened form that it usually presents at that age. 4. Elongation by lateral as well as frontal and occipital pressure. In this form the head is symmetrical, and the sides compressed. It is produced by bandages passing round the forehead, vertex, and occiput, and is variously modified, according to the mode in which these are disposed. The Aymara Indians of the neighbourhood of Lake Titicaca, in Peru, some of the tribes in Vancouver's Island, and the *Macro-*

cephali of the shores of the Euxine, present examples of this form.

As far as can be ascertained by observations upon the North American Indians, no impairment of the intellect is produced by these strange alterations of the form of the cranium, and consequently of the brain. The families of the chiefs, in which alone it is practised in many tribes, maintain their ascendancy over the lower orders and slaves with undeformed heads. Foville, however, appears to have traced numerous cerebral lesions among the peasant population of France to the custom of tightly bandaging the heads of infants.

No motive can be alleged for this singular and wide-spread practice, except blind obedience to custom or fashion, precisely as in many analogous cases of barbarous distortions or mutilations of parts of the body, the origin of which is lost in the depths of antiquity. Without looking as far off as China, very few men or women in England can boast of feet which are not quite as much altered by artificial compression in youth from the form given by nature as are the heads of the Chinook Indians. The far more injurious constriction of the waist, so commonly practised by women of nations which occupy the highest rank of civilisation yet attained by mankind, is only another example of the same strange propensity to tamper with a form which good sense as well as good taste ought to teach was the most perfect that could be designed.

The natural history of the population of the great American continent, as it existed before the changes wrought by the European conquest, which followed the adventurous voyage of Columbus, offers an interesting but difficult problem to the anthropologist. Do all the various tribes (1,700 are enumerated by Keane, and these must be but a small portion of those formerly existing), extending from the Polar Sea to Cape Horn, through such various climates, and inhabiting regions so diverse in their physical characters, belong, as many writers have averred, to one primary division of the human species, or are they capable of being divided into groups, having as strongly-pronounced distinctive characters as are to be found among the inhabitants of the old world, as has been stated by others? Again, if we find difficulty in dividing them into well-marked groups, do we find such uniformity of characters as to lead to the belief that they are all of common origin, or have we reason to think that they are the result of the mingling together in various proportions in different districts of two or more distinct sources of population? Furthermore, inquiry will naturally be directed to their relation with other people. Whether we consider them as one or as several people, we shall have to ask with which of the races of other parts of the world are they most nearly allied.

The views till lately held as to the peopling of America, though perhaps under various modifications and disguises, may be grouped under two heads:—(1) That the inhabitants of that continent were a distinct autochthonous or indigenous people, created in the country in which they were found, and therefore not related to those of any other land. This is the theory of the polygenetic school, but is probably not held by many scientific men of the present day. 2. The monogenists mostly believed that they are descended from an Asiatic people, who in comparatively recent times passed into America by way of Behrings Straits, and thence spread gradually over the whole continent, as far as Cape Horn, and that their nearest allies must therefore be looked for in the north-eastern regions of Asia. It has also been thought by those who have held the same general views, that at all events a partial peopling of the American continent may have occurred from Southern Asia, by way of the Polynesian Islands, or from North Africa, across the Atlantic. The discovery of the great antiquity of the human race in America, as well as in the Old World, has led to an

important modification of these theories. The proof of a very considerable antiquity rests upon the high and independent state of civilisation, which had been attained by the Mexicans and Peruvians at the time of the Spanish conquest, and the evidence that that civilisation had been preceded by several other stages of culture, following in succession through a great stretch of time, but the antiquity of the quasi-historical period thus brought out, is entirely thrown into the shade by the evidence now accumulating from various parts of the United States, Central America, and the Pampas, that man existed in those countries, and existed under much the same conditions of life, using precisely similar weapons and tools, as in Europe, during the pleistocene or quaternary geological period, and, perhaps, even further back in time. As in Europe his works are found associated with the remains of *Elephas primigenius*, and other extinct mammals, so in America are they found in contemporary deposits with those of *Elephas columbi*. If the inductions commonly made from these discoveries be accepted, and the fact admitted that men lived both in Europe and America before the surface of the earth had assumed its present geographical conformation, the data from which the problem of the peopling of America is to be solved are altogether changed. Recent palæontological investigations, especially those carried on with such great success in the neighbourhood of the Rocky Mountains, show that an immense number of forms of terrestrial animals that were formerly supposed to be peculiar to the Old World are abundant in the New; indeed many, such as the horses, rhinoceroses, camels, &c., are more numerous in species and varieties in the latter, and therefore the means of land communication between the two must have been very different to what it is now. Taking all circumstances into consideration, it is quite as likely that Asiatic man may have been derived from America, as the reverse, or both may have had their source in a common centre, in some region of the earth now covered with sea.

However this may be, the population of America has been for an immense period practically isolated from the rest of the world, except at the extreme north. Such visits as those of the early Norsemen to the coasts of Greenland, Labrador, and Nova Scotia, or the possible accidental stranding of a canoe containing survivors of a voyage across the Pacific or the Atlantic, can have had no appreciable effect upon the characteristics of the people.

The evidence derived from the study of the physical characters of the Americans shows that there is, considering the vast extent of the country they inhabit, and the great differences of climate and other surrounding conditions, a remarkable similarity in essential characters, with, at the same time much diversity in detail, and in other characters which perhaps are not of such primary importance as has often been thought. The construction of the numerous American languages, of which as many as 1,200 have been distinguished, is said to point to unity of origin, as, though widely different in many respects, they are all, or nearly all, constructed on the same general grammatical principle, that called *polysynthesis*, which differs from that of the languages of any of the Old World nations. In mental characteristics all the different American tribes have much that is in common, and the very different stages of culture to which they had attained at the time of the conquest, as that of the Incas and Aztecs, as contrasted with that of the hunting and fishing tribes, which has been quoted as evidence of diversity of race, were not greater than those between different nations of Europe, as Gauls and Germans, and Greeks and Romans in the time of Julius Cæsar; yet all these were Aryans, and in treating the Americans as one race, it is not intended that they are more closely allied than the different Aryan people of Europe and Asia.

The physical or anatomical characters of the American native people, taken as a whole (leaving out for the present the Eskimo), may be thus described:—In stature there is considerable variation. Among them are the tallest known people on the earth, the Tehuelches or Patagonians, who, though not the fabled giants of the early voyagers, appear, by all trustworthy accounts, to attain an average (for the men) of from 5 feet 10 inches to 6 feet, which exceeds that of any other race. Some of the North American Indians are also very tall, 381 Iroquois carefully measured during the late war giving a mean height of 5 feet 8.3 inches. On the other hand, the Fuegians, and especially the Peruvians, are small, the latter not averaging more than 5 feet 3 inches. There is, however, no pigmy race on the American continent, like the Bushmen, Negritos, and Lapps of the old world.

The hair, always a character of primary importance in zoological anthropology, is remarkably uniform. Its prevailing, if not universal, colour is black, or intensely dark brown. The pale and auburn colour of the hair of Peruvian mummies is probably due to accidental bleaching, and the fair hair, said occasionally to be met with in existing tribes, may be the result of European admixture. It is always straight and lank, though sometimes coarse and sometimes silky in texture, a variation dependant upon the thickness of the individual hairs. In transverse section it approaches the circular form, perhaps more nearly than in any other race, though in this and other characters it resembles that of the Asiatic Mongolian people. On the scalp the hair grows abundantly and often to a great length; in many North American Indians it has been known to trail upon the ground when standing upright. Not less characteristic is the rarity or absence of hair on the face and other parts of the body. The skin is smooth and soft, and of various shades of brown, though cinnamon (commonly called *copper* colour) is the most characteristic. Some Californian Indians and the now extinct Charruas of Uruguay were said to be nearly black; and some scattered tribes, both in North and South America, are described as being nearly as fair as Southern Europeans. The shade of the colour appears to have no relation to the external conditions, such as heat, moisture, &c. Though the features of various tribes, and of particular individuals in each tribe, show considerable diversity, a characteristic type prevails throughout the great majority of the whole people from north to south. The forehead is usually retreating; the face wide in the malar region, narrowing towards the chin; the brows prominent, overshadowing rather small, sleepy, half-closed eyes; the nose long from above downwards, and narrow; the dorsum, as seen in profile, usually arched, rather sunk at the root, then projecting somewhat horizontally, and making a tolerably sharp bend down to the tip, which is not produced down below the septum; though this form is very frequently met with among all tribes, there is some diversity, and the profile is sometimes simply arched and sometimes straight, but a broad flat nose is very rarely met with; the mouth is wide and prominent, the lips rather thin; the chin well formed, narrow, but prominent; the whole face below the eyes long and large, the malar bones projecting laterally, and the lower jaw large.

(To be continued.)

VARIATIONS FROM MARIOTTE'S LAW

THE universal application of the law enunciated by Mariotte and Boyle, that the "volume of an æriform body is inversely as the pressure to which it is exposed," was brought into question at an early date after the publication of the famous experiments on which the principle was based. Oersted and Schwendsen established in 1826 for easily liquefiable gases that the elasticity does not keep pace with the pressure. At about the same