which took place somewhere about 1825; it did not reach this region, however, until considerably later, and did not lead to a very extensive settlement; the Yao have also come from the south-west during the last fifty to sixty years, not in mass, but as a peaceful penetration; they are a virile race, and their arrival is a desirable thing for this region.

These coastal lands have been the scene of raids and counter-raids from time immemorial. In medieval times they were swept by the irresistible Ma-Zimba, and later were ravaged by Arab slave traders from Zanzibar; then came the German occupation, and in 1905–6 the people rashly took an active part in what is known as the Maji maji rebellion, which was ruthlessly crushed by the Germans, and it is said that some 120,000 natives perished. In the War the area was the scene of desperate fighting between the Germans and the British expeditionary force, all peaceful development being necessarily suspended for the period of this struggle. The Tanganyika administration is, however, now endeavouring to improve the economic condition, but it is a slow and tedious work.

The women of the Mwera, Makonde, and Makua tribes affect an extraordinary ornament called the *pelele*; the upper lip is pierced, the hole is gradually enlarged, and eventually a wooden disc, often as much as two inches in diameter, is inserted and worn. In addition, the lower lip is sometimes pierced and a peg or pin of bone or iron is suspended from it. The origin of this curious custom is not certain, but the coast people assert that it is of recent origin and was done to prevent the women being carried off by the slave traders; for one so mutilated had little value in the slave market. If this explanation is correct, it is curious to find the practice persisting to the present day; this generation will, however, see it disappear. The Yaos never adopted it; their women, however, pierce the side of the nose and insert a stud of wood ornamented with inlaid specks of white metal and called the *chipini*.

Vigorous native communities can only develop where natural conditions are favourable, in an area of natural fertility and abundant water supply. In the whole of the wide strip of bush land behind the east coast of Africa, from Kenya Colony to Portuguese territory, the conditions are very rigorous. The soil is fertile, but the rainfall is exiguous, and the permanent water supplies are scanty; years of drought are more common than seasons of plenty. The people become to some extent seasonal migrants, and the development of large settled communities is impossible. How can they form large villages when in the dry season it may be necessary for the women of a village to make a journey of two hours to fetch water from a filthy water-hole for cooking and drinking purposes? Little wonder also that, when they are lucky enough to harvest a good crop, they convert too great a proportion into beer, have orgies to celebrate their good fortune, and fail to lay by enough for the inevitable shortage which will ensue. The unhealthiness of the country, moreover, cannot fail to have an unfavourable effect on their vitality, for they are perpetually exposed to the onslaught of the Anopheles mosquito; their huts are infected with Ornithodorus ticks; the bush is tsetse-ridden; and the stagnant water supplies infect them with intestinal parasites. Even leprosy is not uncommon. These natives are, however, no lower in natural intelligence than those of other portions of Africa, and, when taken out of their squalid surroundings and trained under European influence, they are proved to be capable of considerable mental development; in their homeland their environment weighs them down.

Such is the land in which these wonderful fossil remains occur, and it may be gathered that their detailed exploration is not an easy task or one which can be hurriedly carried out. During the rains the vegetation spreads with great exuberance; foliage appears with a rush, the growth of the grass and the tendrils of creepers being remarkably rapid. The mantle of vegetation is so dense that all prospecting work for new outcrops has to be suspended. In a month or two all this beautiful greenery withers, very soon the grass fires begin, and the scene is changed from one of beauty into a blackened waste. The shade temperature rises to more than 100°, the nights become hotter, so that only hardened, devoted men can maintain their working energy under such arduous conditions.

This picture of the conditions to be encountered is not intended to deter, but to demonstrate that the task of thoroughly investigating this momentous discovery is one which requires the careful organisation of a team of workers, well fed and well looked after, and if possible all anxieties regarding transport and supplies should be taken off the shoulders of the technical staff. In this way results of the utmost value will assuredly be obtained.

Sex-Determination.

By Dr. F. A. E. Crew.

Sex is the term used to define the differentiation of individuals for the production of dissimilar gametes—the ova and the sperm. A male is an individual efficiently equipped for the elaboration of functional spermatozoa and for the conveyance of these towards the site of fertilisation. A female is an individual equipped for the elaboration of functional ova, for the conveyance of these towards the site of fertilisation, and often also for the transit of the zygote—the fertilised egg—at some stage of its development to the exterior. Associated with these differences in the internal and external reproductive organs there are others in the general characterisation, the phenotype, by which male and female can be distinguished on inspection. Further, the sexes can be distinguished by differences in the chromosome constitution of the cells of which the individual is built up.

During the process of cell division, changes occur in the nucleus of the cell by which the contained chromatin material resolves itself into a certain number of filaments of definite shape, and these become progressively shorter to assume the form (in many cases) of stout rods—the chromosomes—which arrange themselves on the equator of the spindle. The number of chromosomes is constant in and characteristic of the species to which the individual belongs. In certain stages of cell activity the chromosomes group themselves to form a characteristic arrangement and it can then be seen that they are associated in pairs, the members of each pair being identical in size and shape.

With the exception of one pair, the chromosome picture is similar in both sexes. In one sex this exceptional pair consists of equal mates, whereas in the other there is one chromosome similar to these, but its mate is either unequal or absent. Since the sexes differ chromosomally in this way, the exceptional chromosomes are referred to as the sex-chromosomes; and of these, those similar in size and shape are known as the X-chromosomes; the unequal mate of the X in the one sex is known as the Y-chromosome. The chromosomes other than the sex-chromosomes are known as the autosomes, and are identical in both sexes. One sex is Xo or XY, the other is XX in sex-chromosome constitution.

It is an established fact that in each gamete—the mature reproductive cell—only one member of each pair of chromosomes is present. In the case of the one sex, each will possess one half set of autosomes and one X-chromosome (1A + 1X); in the case of the other sex there will be two kinds of gametes, those that carry 1A + 1X and others that bear 1A alone or 1A + Y. In the mammal it is the male that elaborates two kinds of gametes, the X-bearing and the no-X or Y-bearing, while the female elaborates but one; in the case of the bird it is the female that is hetero- or di-gametic and the male that is homogametic, elaborating but one kind of sperm so far as the elements of the sex-chromosome organisation are concerned. In the case of the mammal an X-bearing egg can be fertilised either by an X-bearing or by a no X-bearing sperm. In the former case an XX zygote will result having the typical female sex-chromosome constitution, in the latter an Xo or XY zygote will result having the typical male sex-chromosome constitution.

It has not only been shown that there are in certain cases demonstrable differences in the chromosome content of the two sorts of gametes elaborated by the heterogametic sex, but also in many mammals, by measuring the length of the sperm-head, it has been shown that there are two intergrading size-classes; it is suggested that the larger sperm is the X-bearing—the female-determining.

The chromosome theory of heredity assumes that all hereditary characters are determined by genes, and that these are resident in the chromosomes, each having its own particular locus in a particular chromosome. The facts that emerge from the study of the mode of inheritance of the so-called sex-linked characters force an adherent to this theory to the conclusion that the genes for such characters are resident upon the X-chromosomes, and that other genes, some on the sex-chromosomes and some on the autosomes, are directly concerned in the determination of the characters maleness and femaleness.

It is an established fact that the heterogametic individual receives its single X-chromosome from its homogametic parent and that the homogametic individual receives one X from each of its parents. If, then, on the single X-chromosome of the heterogametic individual is borne the gene for a recessive character, it becomes possible to follow the distribution of this X-chromosome by tracing the inheritance of the character. Experimental breeding involving a recessive sex-linked character has shown that, in its transmission from generation to generation, it is bound up in a most intimate way with some mechanism by which the sex of the zygote is determined. A recessive sex-linked character of a heterogametic male will be exhibited by none of his children and by none of his granddaughters but by half of his grandsons; a recessive sex-linked character of a grandmother will be exhibited by none of her children or grandsons, but only by half of her granddaughters.

These facts can most readily and most satisfactorily be interpreted by postulating that the genes for sex-linked characters are resident in the X-chromosomes and also that the X-chromosomes carry genes that are concerned in the determination of sex. The conclusion also emerges that the sex of the zygote is decided by the simplex or the duplex condition of some component which, when present in duplicate, leads to the establishment of femaleness in the mammal and maleness in the bird. The evidence suggests that there is a sex-determining mechanism, an XY mechanism; that the sex-chromosome constitution of the male is Xo or XY in the mammal, and XX in the bird; and that of the female XX in the mammal and Xo or XY in the bird.

In the two sexes the ratio X-chromosomes : autosomes is different, and this suggests that sex determination is not merely an affair of the sex-chromosomes but is also decided by the balance between X-chromosomes and the rest. In the mammals 2X : 2A (where A stands for one complete set of autosomes) is associated with femaleness, 1X : 2A with maleness. This contention finds support in the facts of balanced intersexuality in *Drosophila melanogaster*, in which the ratio 2X : 2A is associated with complete femaleness, 1X : 2A with complete maleness, and 1X : 1·5A with pronounced abnormality in the sexual characterisation.

Since the difference in the sex-chromosomes is the only apparent difference in the genetic constitution of the sexes, it follows that in the mammal the X, or something lodged in it, is female-determining, while male-determination is an affair of the rest of the chromosomes. It is reasonable to assume that maleness and femaleness are characters in the modern Mendelian sense, being based on male-determining (M) and female-determining (F) factors resident in the chromosomes, and that in the mammal the female-determining factors are resident in the X-chromosomes and the male-determining elsewhere. In the bird it must be assumed that in the X-chromosomes are resident the male-determining factors. The situation thus arises that in the mammal,

(FX)(FX)M is an XX individual, a "determined" or "genotypic" female,
(FX)M is an XY individual, a "determined" or "genotypic" male,

whilst in the bird

(MX)(MX)F is an XX individual, a "determined" or "genotypic" male,
(MX)F is an XY individual, a "determined" or "genotypic" female.

By genotypic is meant according to the genotype—the sum total of the genes in the hereditary constitution of the individual.

At the moment when its sex is determined, the individual is but the fertilised egg. The sexual characters that will define and distinguish it are yet to be expressed. Growth and differentiation precede characterisation, but in the main the characters of the mature individual are simply the expression of the genotype. Before the genotypic male becomes the phenotypic male—an individual equipped to function as the elaborator of sperm—the complicated processes of sexual differentiation must be pursued. It is assumed that these processes are directed by genetic action, that the genes—whatever they may be—elaborate specific chemical substances which model and direct the development of the individual. It is assumed that the sex-determining genes elaborate specific sex-differentiating substances—male-differentiating and female-differentiating respectively—and that these provoke responses especially in the developing structures of the sex-equipment of the individual.

During the development of the mammal there is a period during which the differentiation of the sexual organisation is timed to take place. At the beginning of this period, which follows a preliminary phase of growth and organ formation, the reproductive system consists of (1) paired gonads of indifferent histological structure; (2) a rudimentary accessory sexual apparatus composed of Müllerian and Wolffian ducts; (3) external genital organs represented by the growing urogenital sinus and genital tubercle. From this initial type of reproductive architecture possessed in common by all individuals, determined male and female alike, one or other type of differentiated sexual organisation, male or female, is attained. The indifferent gonads become either testes or ovaries; if they become testes then the Wolffian ducts continue their development to become the functional deferent ducts of the testes, while the further development of the Müllerian ducts ceases and the external genitalia become scrotum and penis. If the indifferent gonads become ovaries, the Müllerian ducts continue their development to become the functional uterus with cornua and vagina, while the development of the Wolffian ducts ceases and the external genitalia assume the form of vulva and clitoris. Sexual differentiation is alternative, and the end-product is an organisation appropriate to the functional female or else to the functional male.

Between the differentiation of the various structures of the sex-equipment there is a time relation. The first structure to begin its differentiation is the gonad. The results of castration and gonad-implantation have shown perfectly clearly that in the mammal the differentiated gonad is necessary for the appropriate differentiation of the rest of the sex-equipment. In the presence of functional testicular tissues, the sexual organisation appropriate to the functional male is assumed; in the presence of functional ovarian tissues, that appropriate to the functional or phenotypic female. Such differentiation is pursued under the control of specific male and female sex-hormones, elaborated by the testis and ovary respectively. It is necessary only to explain the differentiation of the embryonic gonad in order to explain the complete assumption of the sexual characterisation.

This can be done if it is assumed that the gonad in its indifferent stage is ambivalent as regards its future mode of differentiation (though not completely so since its tissues as regards chromosome constitution are genotypically either male, Xo or XY, or female, XX), and that this differentiation is pursued under the direction of male-differentiating and female-differentiating substances elaborated by the male-determining and female-determining factors respectively. In the genetically-determined male, (FX)M, of the mammal, it is the rule for the male-differentiating substances to be effectively in excess over the female-differentiating substances, $1F < 1M$, during that period of development when the differentiation of the gonad is timed to take place, whereas in the genetically determined female, the female-differentiating substances are effectively in excess during this period, $2F > 1M$. In the case of the bird the relations of M and F are reversed. In the male, (MX)(MX)F, $2M > 1F$, and in the female, (MX)F, $1M < 1F$.

As a direct result of genetic action the male becomes possessed of testes, the female of ovaries. The gonads become differentiated and the sex-hormones are liberated. These sex-hormones, testicular or ovarian respectively, reinforce the maleness or the femaleness of the individual and direct the differentiation of the rest of the sex-equipment, as the constituent structures of this attain the appropriate degree of growth and become capable of responding to the stimulus of the appropriate sex-hormone. The genotypic male develops testes because he is a genotypic male: he becomes a phenotypic male because he has developed testes. The genotypic female develops ovaries because she is a genotypic female; she becomes a phenotypic female because she has developed ovaries. In the insect the situation is different. The gonad plays no part in sexual differentiation and the phenotype is based directly on the genotype.

Recent work has shown that the "efficiency" of the sex-determining factors differs in different cases; some elaborate their sex-differentiating substances at a quicker rate than others, or come into action earlier. There are quickly elaborating and relatively slowly elaborating male-determining and female-determining factors. This conception can be illustrated by assigning arbitrary numerical values to these factors. M_1, M_2, M_3, M_4, and so on, and F_1, F_2, F_3, F_4, are male-determining and female-determining factors of relatively different efficiencies. Different combinations of such factors are possible. In the mammal a genetic male is an XY (or Xo) individual. On the X-chromosome are resident the female-determining genes, on other chromosomes are the male-determining genes, symbolised as F and M respectively, and these may be F_1 or F_5, M_1 or M_4, according to the genotype of the parent from which each was received.

The situation can thus arise in which in the genotype of such a male there may be a combination of male- and female-determining factors, in which, though in the end 1M would be greater than 1F, yet because the female-determining factors were relatively quickly-elaborating and the male-determining genes relatively slowly-elaborating (F_5, M_1, for example), the female-differentiating reactions would be in efficient excess during the earlier stages of the period of sexual differentiation. Hence, if the differentiation of the gonads is not a matter of a moment but occupies a certain amount of time, the whole or a part of their differentiation would be pursued under the direction of the female-differentiating reactions and ovarian tissues would be laid down. Later, when the male-differentiating reactions had ultimately overtaken and replaced the female-differentiating, if differentiation is not complete, the rest of the differentiation of the gonads would be into testicular tissues, so that a condition of "glandular" hermaphroditism would result. Since the type of the differentiation of the rest of the sexual characterisation is modelled by the kind of gonadic tissue present, this could lead to a marked degree of hormonic intersexuality.

This conception can accommodate the now established fact of the assumption by a genotypic female of the sexual characterisation of a functional male and vice versa. The sex-chromosome constitution does not necessarily correspond with the sexual characterisation. It is not the sex-chromosomes that finally determine sex; it is the sex-determining gene-complex, and disharmony among the elements of this may be such as must lead to the assumption of a totally inappropriate sexual characterisation. Further, the situation is created in which environic agencies provoking disharmony can lead to intersexuality and even to sex reversal, which is not the transformation of a female into a male or vice versa, but merely the assumption by an individual genotypically of one sex of the sexual phenotype usually associated with the opposite: genotypically the individual remains unchanged. If sex reversal overtakes an individual of the heterogametic sex, it will continue to elaborate two kinds of gametes even though it functions as an individual of the sex which usually is homogametic, and this fact will be evidenced by the sex-ratio among its offspring. The sexual characterisation of an individual can be classified as (*a*) *Primary genotypic characters* (the sex-determining factor complex, usually defined by the sex-chromosome constitution, XY or XX). (*b*) *Secondary genotypic characters* (the sexual phenotype). These include the *Primary gonadic characters* (ovarian or testicular organisation of the gonads). In the insect all the sexual characters are secondary genotypic. In the case of the bird and mammal some are (*c*) *Secondary gonadic characters* (depending for their expression and maintenance upon the activities of the functional gonads).

Obituary.

PROF. JAMES WARD.

BY the death of Dr. James Ward, Cambridge has lost one of its most distinguished teachers and British philosophy a man who by general acknowledgment was, along with the late Mr. F. H. Bradley, one of its leading figures. He passed peacefully away on March 4, at the advanced age of eighty-two years, universally beloved and respected, retaining to the end his intellectual vigour, and continuing his work in the University until the illness of his last few days compelled him to desist. The January numbers of *Mind* and the *Hibbert Journal* contain articles from his pen which show that he had lost none of his critical alertness, while two years ago he published an elaborate "Study of Kant," the result of long and sustained research. Until a few months before he died, he was contemplating writing a comprehensive volume on epistemology; as a matter of fact, he had written some chapters of it, a series of articles he contributed to *Mind* during the years 1919 and 1920 constituting one of them.

James Ward was born at Hull on January 27, 1843. The home of his parents was, however, in Liverpool. Here he spent his school-days, and, on their termination, he was articled to a firm of architects. But he soon abandoned the idea of following a business career, and entered Spring Hill College to prepare for the work of the Christian ministry. For a period of twelve months he actually was minister of the Congregational Church at Cambridge. Then he discovered that his theological views were out of accord with those of the members of his congregation, resigned his charge, and entered Trinity College, where he came under the inspiring influence of Henry Sidgwick. He was already a graduate and gold medallist of the University of London, and was placed alone in the first class in the Moral Sciences Tripos of 1874, being elected a fellow of Trinity in the same year. In his fellowship dissertation on "The Relation of Physiology to Psychology" there can be traced the germs of many of the principles he afterwards worked out in detail.

Ward then proceeded to Germany, where he studied under Lotze at Göttingen and under Ludwig at Leipzig. Of both these teachers he always spoke in terms of the warmest admiration, and there is no doubt he was greatly influenced by Lotze in reaching his own philosophical position. He was appointed lecturer in moral science at Cambridge in 1881. For many years he devoted himself chiefly to psychology, and it was under his guidance that Cambridge gradually became a centre of psychological research. He was instrumental in starting a Psychological Laboratory almost about the same time that Wundt began experimental work in Leipzig. Bringing to the study of psychology a wide and thorough knowledge of biology and physiology, he was enabled to interpret the facts of mind with the aid of evolutional conceptions in a way that had never before been attempted. Michael Foster used to tell him that he was a "physiologist spoilt"; but he certainly atoned for his desertion of one science by completely revolutionising another.

Croom Robertson was to have written the article on "Psychology" for the ninth edition of the "Encyclopædia Britannica," but was prevented from doing so through failing health. Ward undertook to provide the article; he began writing it in 1884, incorporating the substance of certain papers of his which had already appeared in periodicals, and it was completed in 1885. A supplementary article was prepared by him for the tenth edition of the Encyclopædia in 1885; and finally,