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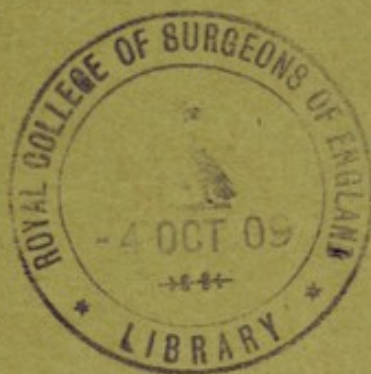
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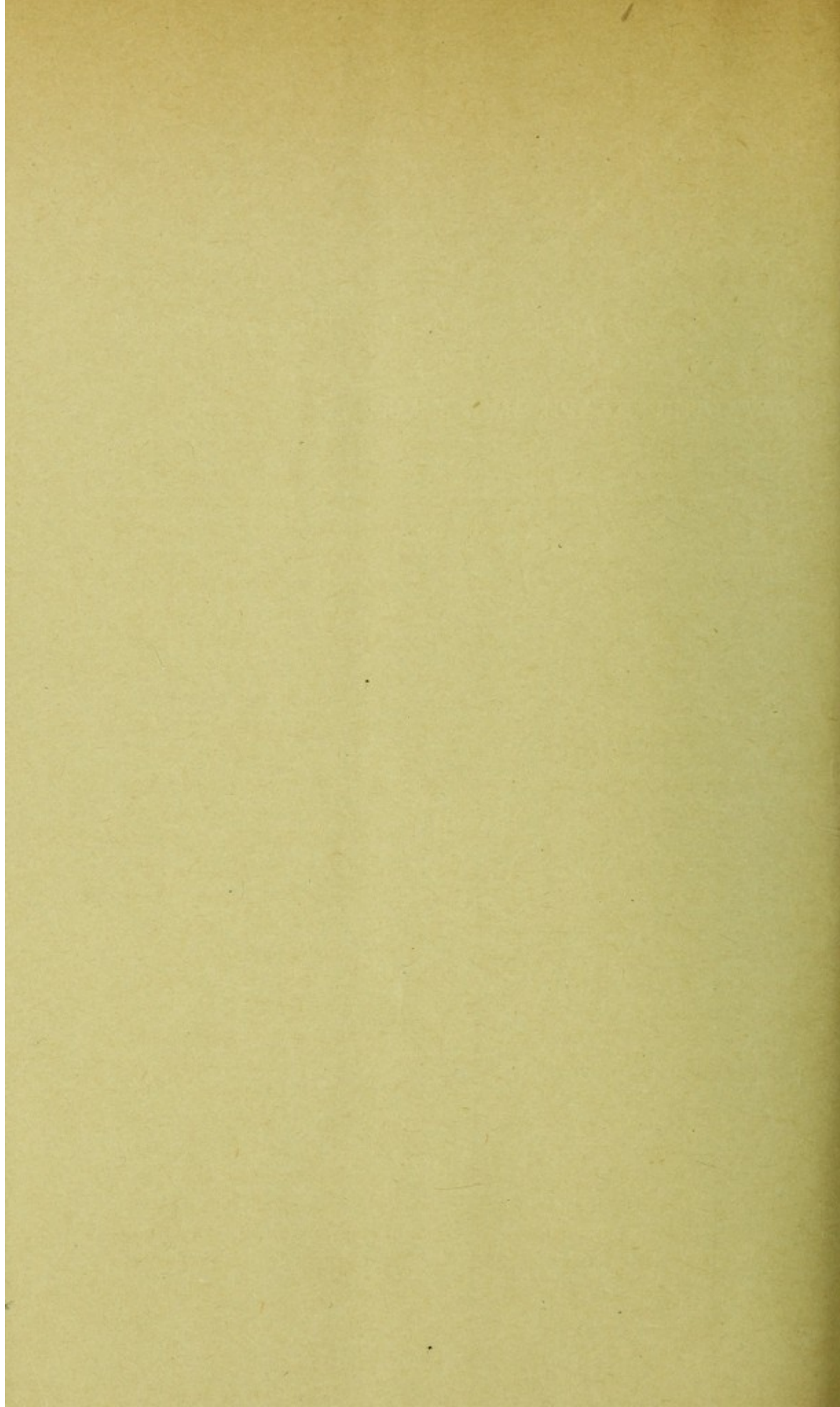
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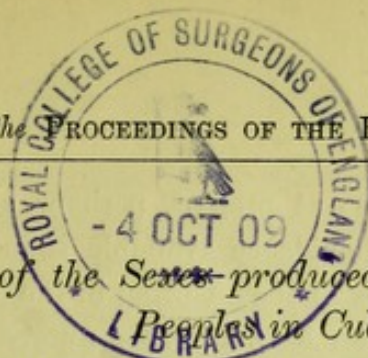
*The Proportion of the Sexes produced by Whites and Coloured Peoples in Cuba.*

By WALTER HEAPE, M.A., F.R.S.









*The Proportion of the Sexes produced by Whites and Coloured Peoples in Cuba.*

By WALTER HEAPE, M.A., F.R.S., Trinity College, Cambridge.

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(Abstract.)

*Introduction.*—Darwin, in his great work on the Descent of Man, deals with the proportion of the sexes in various animals and the power of natural selection to regulate the proportional number of the sexes. He recognises a general tendency to equality of the sexes but remarks on the fact that this equality is often greatly disturbed. In certain rare cases of marked inequality he concludes they might have been acquired through natural selection, but in all ordinary cases, such as, for instance, the difference in the proportion of the sexes in legitimate and illegitimate children, it can hardly be so accounted for and must be attributed to unknown conditions, although, he adds, natural selection will always tend to equalise the relative number of the two sexes.

About that time a host of writers were engaged in investigating various possible causes for this inequality, and many theories were promulgated to account for it, such as the relative age of the parents, the time of conception, and so forth. Prominent amongst them was Düsing, who set himself to show that nutriment was the chief determining factor. He set forth his case with great ability and brought an enormous mass of evidence in support of his view.

Students of heredity in those days claimed that the laws of heredity were sufficient to account for all inequalities, but Düsing emphatically denied this, and in my opinion satisfactorily showed he had sound reason for doing so.

During the last few years much work has been done on sex, especially regarding the factors which determine sex, and strong evidence has been brought to show that both individual spermatozoa and ova are themselves of definite sexuality. It is suggested that the sex of the individual resulting from the conjugation of a spermatozoan and an ovum must be determined by one or other of them, not by both, and it is claimed that, in order to fulfil the conditions, a M. ovum must be fertilised by a F. spermatozoan and, *vice versa*, a F. ovum by a M. spermatozoan. So far as the evidence available now goes, it would seem possible that in some animals the sex of the offspring is determined by the spermatozoan and in other animals by the ovum. The facts are not clear, however, though it is to be hoped the efforts now being made by



the Mendelians will make it so; at present, perhaps, all that can be said regarding mammals is that the evidence available is in favour of the view that the ovum determines the sex of the offspring in these animals.

Now a female mammal produces only a limited number of her ovarian ova during her life, others degenerate and are absorbed, in fact, some ovarian ova survive at the expense of others and it would appear that this process goes on with more or less activity at different times. Thus there is a struggle for existence and a process of selection going on in the mammalian ovary, and this is a very important fact, for the projection into the ovary itself of forces which are undeniably produced by extraneous conditions shows that such conditions must to some extent influence the output of the ovary.

A wealth of evidence has been adduced by many observers to show that M. and F. larvæ are very differently affected by different foods and different climatic conditions, and this evidence is overwhelmingly in favour of the view that F. larvæ require more nourishment, more favourable conditions, than do M. larvæ for their development. But if this is true for larvæ it is surely true also for ovarian ova, and the conclusion may be confidently drawn, that the selection of M. or F. ovarian ova, for production, is liable to be influenced by the food supplied to the ovary by the mother and therefore by the conditions of metabolic activity she experiences.

As all breeders know, the breeding power of an animal is in direct relation to its metabolic activity, and the metabolic activity of a mother is undoubtedly affected by the food supplied and the climatic conditions she experiences; thus it would appear that extraneous conditions must exert influence on the proportion of the sexes produced by all animals in which a struggle for existence takes place among the ova in her ovary.

This view, it appears to me, explains a variety of facts which have been judged to be contradictory, and brings into line the results of many observations which have hitherto been supposed to favour now one, now another, quite different theory. For instance, all the contradictory evidence I have examined regarding the effect on the sex ratio of the ages of the parents and the times of conception, may be so accounted for, while upon the phenomena concerning sex ratio observed in consequence of crossing or of in-breeding, a new light is thrown which will, I think, go far to show adequate reason for the results obtained for mammals. It must not be supposed that I attribute the proportion of the sexes produced to these agencies alone; there can be no doubt, in my opinion, that heredity is the main force at work, but it is incontrovertible that variations in that proportion constantly occur, and I maintain that these variations cannot be accounted for by any law of heredity and are referable to those extraneous forces which act as selective



agents on the ovarian ova. The evidence I have to offer in the following paper is, I think, strongly confirmatory of this view.

1. *Data dealt with.*—From a statistical point of view, human beings are the only mammals for which sufficiently large numbers can be obtained with any hope of ensuring sufficient accuracy, and for these there has always been difficulty in assuring oneself of the completeness of the records at any one time for more than one race. When, therefore, my friend, Dr. F. H. H. Guillemard, pointed out to me that the publications of the chief sanitary officer of Cuba supplied separate details of the births and still-births of whites and coloured people in the island, and that these records were further subdivided into legitimate and illegitimate births and still-births, I communicated with that officer (Dr. Finlay), and he has very kindly supplied me with a complete series of his monthly publications for the years 1904-5-6. It is with these records I now deal. The numbers dealt with amount to—

Births—whites, 131,721 ; coloured, 39,576. Total, 171,297.

Still-births—whites, 4160 ; coloured, 2247. Total, 6407.

Total production—whites, 135,881 ; coloured, 41,823. Total, 177,704.

Deaths—whites, 52,087 ; coloured, 27,877. Total, 79,964.

Marriages—whites, M. 31,481, F. 31,240 ; coloured, M. 7598, F. 7839.

Total, M. and F. (each) 39,079.

These totals are arrived at from monthly records, for each of these three years, for each of the six provinces into which the island is divided ; and in each case, except for marriages, the proportion of M. per 100 F. has been calculated. Altogether I have drawn up 64 tables of these and similar details ; they are dealt with more fully elsewhere, the results thus obtained I now summarise.

2. *The Racial Proportion of the Sexes.*—The first prominent fact demonstrated is the difference in the proportion of the sexes produced by the two races. The whites produce a larger proportion of M. than the coloured people. For whites, the proportion varies during these three years from 106·8 to 110·52, in the total it is 108·44 M. per 100 F. ; for coloured, the proportion varies from 101 to 101·2, total 101·12 M. per 100 F. ; and this racial difference is shown both for births and still-births.

Here, then, we have a marked racial difference which, after examination of other statistics of coloured people and of the inhabitants of Spain (from whence most of the white inhabitants of Cuba originally came), I am of opinion may confidently be assumed to show that, in this particular, the influence of heredity is clearly demonstrated.

3. *The Sexual Ratio in Legitimate and Illegitimate Births.*—The second



prominent fact is the consistent variation in the proportion of the sexes produced in consequence of legitimate or illegitimate union. This is evident both for births and still-births in both races, and emphatically shows that illegitimate union results in the production of a marked increased proportion of F. For whites, the total legitimate births show 107·78, while the illegitimate show only 104·4 M. per 100 F. For coloured, legitimate births show 106·76, and illegitimate 96·76 M. per 100 F. The records of still-births show a difference of 10·06 more M. among legitimate still-births for whites, and 16·63 more M. in that class for coloured people; but the proportion of M. among still-born children is vastly higher than among births, the totals for whites and coloured for the three years being in proportion of 144·45 M. per 100 F.; thus, when births and still-births are added together, the result of legitimate union among whites gives 109, of illegitimate union 105·95 M. per 100 F.; among coloured, legitimate unions give 107·73, and illegitimate 97·91 M. per 100 F. Thus this difference, while it is much greater for coloured than for white people, is marked for both races in the totals, and is shown to be a remarkably consistent variation throughout my tables.

It is clear that illegitimate union amongst civilised peoples is due to individual characteristics in the woman which have for their basis a specially active sexuality. Thus the result of illegitimate union, the increased production of F. in consequence thereof, is an individual matter, it cannot be accounted for by any law of heredity and must be associated with physiological conditions which induce this special activity, that is to say with forces which affect the metabolic activity of the woman. I cannot here detail all the arguments in favour of this view and will only add (the evidence admits, I think, of no other interpretation) that, as I have already shown, an exceptionally active metabolism in the mother should favourably affect the development and ripening of F. ova, and that this is what is found to be the case here.

4. *Breeding Seasons*.—An examination of the monthly tables demonstrates the existence of two sharply-defined breeding seasons each year, and shows that they are experienced by both whites and coloured at the same time. One breeding season is more marked than the other, this fact is also common to both races, but both are quite unmistakably shown in the birth tables. The records of marriages show that the marriage season, though it is also quite definitely indicated, has no relation whatever to the breeding seasons. On the other hand, reference to records of temperature, barometric pressure, humidity, etc., shows that these bursts of reproductive activity always take place at times when there is a marked change of climate; the one in the



autumn shortly after a sudden change from great heat to cooler weather, the other in the early months of the year at a time when the cool winter weather gives place to spring. The increased reproductive activity of the people is suddenly acquired and almost as abruptly allayed, it is obviously not a definite temperature but the experience of *a change of temperature* which induces this boisterous generative activity.

The same conditions are found to influence, in a similar manner, other animals which experience breeding seasons, and the effect on stock is increased metabolic activity. There can be no doubt these breeding seasons of the two races in Cuba are brought about by forces which tend to greatly increase the metabolic activity of the individual.

5. *The Effect of the Breeding Seasons on the Proportion of the Sexes produced.*—If, then, I am right in stating that the breeding seasons are induced in consequence of increased metabolic activity, and if my reasoning is sound regarding the increased output of F. among illegitimate births and the influence of different degrees of metabolism on the ripening and production of ovarian ova of different sexes, the result of the breeding seasons should show this.

It does show it, emphatically; my tables demonstrate that the greatest excess of F. is produced at times of greatest fertility, *i.e.* during the breeding seasons, when the metabolism of the mother is most active. This is true for both races and it is clearly shown in all totals and in the totals for each individual month, except for two months of one year for coloured people.

I feel convinced such a variation in the sex ratio cannot be ascribed to the action of any law of heredity; it is clearly associated with the exercise of extraneous forces on the ovary and is, I submit, due to those forces.

6. *The Limitation of the Influence of Extraneous Forces.*—In connection with the above, another fact is shown which is of considerable interest, namely, that while whites show a more marked sensibility to the influences which induce the production of F., coloured people are more affected by the forces which stimulate the production of M., and this condition is more marked among illegitimate than among legitimate birth records.

This fact shows that the race which normally produces a considerable excess of M. is most amenable to the forces which induce the ripening of F. ova, while the race which produces the greatest proportion of F. reacts more generously to the influences which favour the production of M. ova. In other words, there is here demonstrated the exercise of a force which limits the power to produce an excess of either sex, a force which makes for some point near equality of the sexes, and which is, I take it, the force of heredity.



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This exemplifies the nature of the claim I made; extraneous forces undoubtedly exist which effect a variation in the sex ratio, but they are to some extent subordinate to laws of heredity; nevertheless these former forces cannot be ignored, they are certain to interfere to some extent with the performance of the laws of heredity and with all calculations regarding sex ratio which are based solely upon those laws.

7. *The Effect of Town as compared with Country Life on the Sex Ratio.*—Finally, on analysis, my figures show another fact, namely, that a quite considerably higher proportion of F. are born in towns than in the country districts. This is shown in my tables for both races and is evident as a rule in the records for both legitimate and illegitimate births.

I have elsewhere discussed the reason for this; it is quite clear no law of heredity can explain such a variation, and I have concluded that the extraneous forces which are accountable for it must again be associated with the degree of metabolic activity experienced by the mother under variable conditions.

8. *Conclusion.*—Other facts of considerable interest in relation to this work are set forth elsewhere and I will not refer to them here. I have given above three instances of conditions under which the production of M. and F. children shows a marked variation from the normal. The results are similar for both the whites and the coloured races in Cuba. These people have hereditary qualifications which, in the main, govern the proportion of the sexes they produce, but conditions undoubtedly occur under the influence of which that proportion is varied. This variation is similar in character but different in degree for the two races, and is directly associated with definite extraneous forces, food and climate, which affect the metabolic activity of the mother.

Taken singly any one of these instances might be thought to be inconclusive, but taken together they seem to me to present strong evidence of the truth of my contention, that the variable metabolic activity of the mother, acting upon the ovary, induces a struggle for existence between the ovarian ova of different sexes, and affects the proportion of M. or F. ova which ripen and which are produced for fertilisation.

It is worthy of notice that these same extraneous forces must affect the proportionate production of individuals possessing various kinds of different characters (quite other than sex) which are associated with metabolism, and, when better understood, may have valuable bearing on the means for selection of healthy ova and for preventing the maturation of ova bearing the active germs of disease.