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Heredity of twin births.By **C. B. DAVENPORT.***[From the Eugenics Record Office, Cold Spring Harbor, L. I.]*

About 1 per cent. of human births are twin births. However, there are certain families in which the proportion rises to 5, 10, or even 15 per cent. There can be little doubt then that, as in sheep, so in man, there are strains having a special tendency toward the production of twins.

It is commonly believed that this tendency toward the production of twins must be wholly a maternal quality, depending upon the inherited tendency to double ovulation.

The study of the heredity of twins is accompanied by certain difficulties, such as the fact that the occurrence of twins is frequently isolated, apparently haphazard, occurring perhaps in only one case in a fairly large fraternity, in which other representatives are single births. It will simplify the matter a little if we consider only those cases in which two or more sets of twins have arisen from a given mating.

The study of twins is still further complicated by the fact that they are of two types, namely twins derived from a double ovulation and twins derived from a single ovulation, there being a subsequent fission or budding of the fertilized egg. Such single-egg twins are easily distinguished clinically by being both enveloped in the same chorion. They are also always of the same sex.

The statement that the mother alone determines the tendency to twins is not, however, supported by the facts. Of the births giving rise to the fraternities of twin-repeating mothers, 4.5 per cent. are twin births. Of the births giving rise to fraternities of twin-repeating fathers, 4.2 per cent. are twin births. These figures depend upon 355 and 289 labors respectively.

The sisters of twin-producing fathers have twins in 8.2 per cent. of labors, while the sisters of twin-producing mothers have twins in 5.5 per cent. of labors. Among the children of brothers of twin-producing fathers, 6.5 per cent. are twins, among the

brothers of twin-producing mothers 4.5 per cent of the children are twins. These figures indicate that the twin ratio is increased 4 to 7 times in twin-producing families and that the ratio of twin production is about as high on the father's as on the mother's side of a fraternity which contains 2 or more twins. This result disposes of the statement that fathers play no role in twin production, but at the same time raises the query—How can this be?

It is relatively easy to understand how the sperm may influence the early division of the fertilized egg so as to produce identical or 1-egg twins, and we find indeed that the rate of occurrence of twin production is high, both on the paternal and on the maternal side of such fraternities containing identical twins. The rate in both cases is about 13 per cent. But if one takes only those fraternities producing 2 or more sets of twins of unlike sex, we still find an equality of influence on the paternal and on the maternal side.

The difficulty in the way of understanding the equality of the part played by the father and the mother in the production of 2-egg twins arises from the assumption that such twins are due merely to double ovulation. Were they due merely to double ovulation, then there would be as many sets of twins born as there are double ovulations that occur at the time of conception. That this assumption is false is shown by several lines of evidence.

1. Not all of the eggs that are ovulated are fertilized. In the case of 4 sows' uteri examined the number of embryos (well advanced in development) found was 22 and the number of recent corpora lutea 34. This indicates that fully one third of the eggs laid at these periods of conception were not fertilized. This number is, I think, rather too high for a general statement, probably not more than 10–25 per cent. of eggs ovulated at favorable periods fail of fertilization. In humans also there is evidence based upon counts that have been made on the corpora lutea of non-pregnant and pregnant women that the rate of occurrence of 2.3 corpora lutea in the ovary is much greater than the occurrence of twins. Thus, to cite only a single study, in 33 sets of ovaries with corpora lutea or follicles about to burst, 5 (or 15 per cent) showed that double ovulation was occurring. It seems, therefore, certain that many more cases of double ovulation occur than of twins.

Again, of eggs that are fertilized, a certain proportion are aborted at an early age. This fact is striking in mammals also, where occasionally one finds, as John Hammond, 1914, points out and as I can confirm by numerous examinations of the uteri of swine, one or more embryos degenerate at an early stage. Also the medical literature has abundant references to blighted twin fetuses, and the large number of miscarriages under 3 months is a familiar fact. It is probable, since genetic work has revealed a great number of lethal factors, that a large proportion of these atretic embryos is due to such lethal factors.

The foregoing statements lead to the conclusion that our preconception that twinning is due merely to double ovulation needs revision. It is due to double ovulation combined with some other factors that induces a large proportion of such double ovulations to produce viable twins.

The other factor is the paternal one. It depends upon the capacity of the male to fertilize all of the eggs ovulated with sperm which contain no lethal factors. Now, both the capacity for complete fertilization (high fecundity) and the absence of lethal factors in the male germ cells are hereditary factors.

Attention may be called in passing to the fact that in human matings about 10 per cent. are sterile and, among these sterile matings, a certain proportion are physiologically such or at least no imperfections in the reproductive organs of either member of the pair can be detected.

Summary.—The influence of the male in twin production is determined by the circumstance that twin production does not depend merely upon double ovulation but upon such a quality of the sperm as shall result in a high proportion of fertilization of eggs ovulated and a small proportion of fertilized eggs containing lethal factors.