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Abstract. It has been shown previously that the weight (W) of an entire litter of newborn young of multiparous mammals is proportional to the number (N) in the litter. This proportionality may be expressed by the empirical equation

$$W = \overset{K}{N} + C$$

where K is assumed to have the properties of a partition coefficient and expresses the manner in which a limited nutritional supply is shared by the members of the litter. This relationship also holds for human multipara, though it is modified by the inability of the human mother to increase the nutritional level to the same extent as other species we have investigated.

It has been known for some time that a high correlation exists between the average birth weights of litters of many multiparous mammals, and the number of young in a given litter (Enzmann and Crozier, 1934). This correlation may be expressed more precisely by means of the following equation:

$$W = \overset{K}{N} + C \quad (1)$$

where W equals the average weight of an entire litter, N stands for the number of young in the litter, C is the constant of integration and depends on the units of measurement chosen, and K is another constant.

The constant K relates to the manner in which a limited nutritional supply is shared between the members of a litter. It may therefore be called a "partition coefficient". It is non-specific. We have shown earlier (Crozier and Enzmann, 1935) that the numerical value of the constant K is within narrow limits the same for all mammalian species investigated so far (see also Crozier, 1939).

The data presented here are based on statistics of birth weights furnished by the U. S. Department of Health, the Iowa Department of Health, and the unpublished statistics on multiple births of many hospitals and several life insurance companies. We take pleasure in expressing our gratitude to those students of Still College who helped in collecting the data and handling the correspondence.

There are many data available on single human births and twins, but for triplets and quadruplets they are rare. For multiple births involving five children, only the birth weights of the Dionne quintuplets of Canada were available; we were unable to obtain the weights of the Diligenti quintuplets of Argentina. Sextuplets have been reported several times in the literature (Guttmacher, 1956), but none of the children survived for more than a day.

It follows from equation 1 that a plot of the logarithms of the average birth weights to the logarithms of the number of siblings should yield a straight line. Such a plot for "human litters" is shown in Table 1 and in Figure 1.

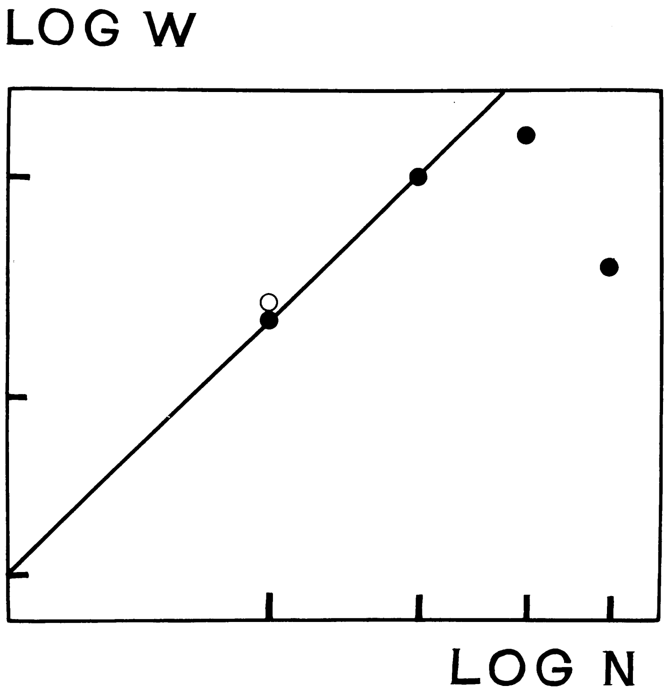

Figure 1. Plot of the logarithms of the average birth weights of sets of human multiple births against the logarithms of the number of newborn in each set. The black circles represent data collected by us from various sources; the white circle is based on data by Potter and Fuller (1949).

Table 1
Average Birth Weights of Human Infants

Number of infants in multiple births	Average weight of set	Number of cases reported
1	3310 g	3.750.000
2	2491 g	*
2	2194 g	**
3	1661 g	66
4	1302 g	44
5	917 g	1

*Based on data by the U. S. Dept. of Health.
**Data summarized from various sources.

The average weights of twins given by Potter and Fuller (1949) fall a little higher on the graph than those given here. The average weights calculated for quadruplets and quintuplets fall below the values calculated from equation 1. The data for these categories are obviousy inadequate.

The results presented here indicate that the birth weight relations found in many multiparous mammals also apply to human multipara. The constant K obtained from plotting human multiple births has a similar value to those of other mammalian species, confirming the theory that it represents a partition coefficient and denotes the equal sharing of a nutritional supply by the members of a litter.

This "equipartition" can also be seen in the tabulation of selected sets of multiple births (Table 2). Though the total birth weights

Table 2

Selected Sets of Quadruplets and Triplets Showing That the Variability in Birth Weight Between Members of the Same Set Is on the Average Less Than the Variability Between the Weights of Infants From Different Sets

Quadruplets:	Set 1	4/2	4/2.5	4/8	4/0*
	Set 2	2/12	3/7	4/0	4/0
	Set 3	1/13	2/11	4/0	2/9
	Set 4	3/0	3/0	3/0	2/6
	Set 5	1/12	2/4	1/2	2/3
Triplets:	Set 1	3/3	4/6	4/5	
	Set 2	3/3	4/5	4/0	
	Set 3	6/4	6/7	6/2	
	Set 4	1/6	1/9	2/4	
	Set 5	3/0	3/4	3/8	
	Set 6	1/4	1/4	1/6	

*The notations 4/2, 4/2.5, etc., denote pounds and ounces. Most of the data are from the report of the Iowa State Department of Health and the U. S. Department of Health.

of litters, for instance triplets or quadruplets, may vary considerably, the weight differences between litter mates are relatively small.

It must be realized that the birth weight of human infants depends on many factors, such as age of the mother, her state of health, litter rank or number of previous pregnancies, etc. Potter and Fuller (1949) state that the length of pregnancy varied from 160 to 320 days, with a corresponding correlation between the length of gestation and the weight of the newborn. Intrauterine mortality also modifies the birth weight. Twins may be born who are actually members of sets of triplets, the third member having died *in utero*. Hospitals often keep misleading records, for instance listing as "twins" a set of triplets in which one of the members was a "paper child" (Greulich, 1930).

Multiple births in humans are rare, as evidenced by the statistics given in various papers on the subject. Quintuplets have not been recorded in the United States during a period of 30 years (U. S. Statistical Bull. 1946). The report of the Metropolitan Life Company (1956) states that during the period from 1934 to 1947 quadruplets were born in 1.6 cases in one million; triplets were about sixteen times as frequent as quadruplets.

The question may be raised as to why the equation relating the average total birth weight to the number of young in a litter does not fit the observed data on human birth weights as neatly as it does in other mammalian species. Many reasons may be given. The data on mice, rats, rabbits, guinea pigs, pigs, etc., reported earlier by us (*loc. cit.*) were based on genetically homogeneous material obtained under uniform environmental conditions. Human material is genetically heterogeneous.

It is obvious that births weights have a lower as well as an upper limit. If the birth weight falls below a specific value, the newborn will not survive. This limit may vary considerably; in human birth it has been set arbitrarily at 1000 grams (Iowa State Department of Health). Potter and Fuller (1949) give the following figures of infant mortality as related to birth weight:

Birth weight	*Percent mortality*
1000-1500	56
500-1000	97
under 500	100

The upper limit of the average total weight of litters is of even greater interest since it depends largely on the ability of the mother to elaborate food substances for her unborn litter. Our own earlier observations, as well as data from the literature, indicate that in all species studied an increase in litter size induced the mother to increase her production of nutrient materials. However, the ability of the mother to produce is not rectilinearly proportional to the litter size; there is an upper limit to the number of young in a litter as well as to the ability of the mother to nourish the litter.

In the animal species which we have investigated, a plot of the logarithms of the number of young in the larger litters against the logarithms of the average birth weights in these litters does not deviate to any large extent from the values calculated from equation 1. This may be restated by saying that multiparous mammals generally do not produce more young than can be nourished by the mother, so as to produce young with "viable" birth weights.

In human mothers, as in other mammals, each additional fetus seems to spur the metabolism of the mother to greater effort. The increase, however, is less than in those species which are normally multiparous. In human multiple births we find therefore a rapid rise of mortality which reaches one hundred percent in sextuplets.

It would seem that the human species is essentially uniparous; the rare cases of multiple births may be considered to be abnormalities comparable to recapitulations of ancestral characters.

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