XVIII. THE RELATION BETWEEN FERTILITY AND NORMALITY IN RATS

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During a recent visit to the west of India I had an opportunity of seeing the work which was being carried on by the Plague Commission at Poona and Belgaum; at both of these places large numbers of rats were being caught daily, each rat being the subject of careful observation. The results of these observations were recorded as a matter of routine, so that no detail, which might have a bearing on the questions before the Commission, might be lost. While watching the progress of the work, and admiring the thoroughness with which it was executed, I received the idea that some of the statistics which were being accumulated might be of great value to Biology. Among the facts recorded was that of the number of young contained in each pregnant female. It is well known that among mammals which produce a number of young at a birth there is an individuality as regards that number. It is the common experience among dog fanciers, that certain bitches will always produce four or five pups at a time, while others will always produce one or two. It very rarely happens that a bitch will produce a large litter at one time and a small one at another time. Therefore we may assume that the number of young produced by a rat at any one time is a fair measure of the fertility of that rat; though imperfect it would be difficult to devise a better means of measuring this important character. From both Poona and Belgaum, I obtained the records of the fertility of one thousand rats as measured in this way. It occurred to me that a definite relation had been established between fertility and normality in the case of certain organisms. Among such organisms it had been found that those which were most normal or true to the type of their race were also the most fertile. I am indebted for this information to a book entitled " Variation in Animals and Plants " by H. M. Vernon. This book quotes the observations of Professor Karl Pearson, who counted the number of stigmatic bands on a large number of poppy capsules and the number of the seeds which ripened in each capsule. The number of the seeds was regarded as a measure of the fertility of the poppies. It was found that those plants which were abnormal as regards the number of their stigmatic bands always contained a smaller number of seeds than those which were normal.

The number of the stigmatic bands varied from 5 to 19 but the most common type of capsule possessed 12 or 13 bands. It is not surprising that those plants which possessed few bands should produce few seeds, but it is most remarkable that those capsules with 18 or 19 bands should also produce few or no seeds. Similar observations were made on other plants; the following passage appears in Vernon's book : " These experiments Professor Pearson holds to illustrate a very important law, namely, ' Fertility is not uniformly distributed among all individuals, but for stable races there is a strong tendency for the character of maximum fertility to become one with the character which is the type.' " It has also been shown that certain medusæ which are abnormal as to the number of their radial canals are less fertile than those which are normal. It is plain that this law is an explanation or discovery of the means by which a race remains normal in spite of variation, for it states that normality can perpetuate itself with ease while abnormality does so with difficulty. This explanation seemed so feasible that I felt almost sure that if the fertility of these rats was to be compared with some other variable character, an interesting illustration of the law would appear. The character chosen for comparison was the weight of the rat. House rats throughout India are very variable in size ; in the combined length of head and body they show a range of variation which is as wide as forty per cent. of the mean length, in weight the range is much wider even than this. The difficulties of measuring a freshly killed rat are well known to any one who has made the attempt; the length of a rat varies with the attitude it is made to assume, and the interval of time since its death. Although the weight of a rat doubtless varies according to the stage in the pregnancy reached, the contents of the stomach and the state of the nutrition, a record of the weight affords the best estimation of the total size which is available to us.

The result obtained was quite unexpected. The maximum fertility of rats (as measured by the number of young which they produce at a birth) is not one with the character which is the type, as regards size. In other words, gigantic and dwarfed rats are just as fertile as common rats of average size.

The tables I and II show the results which were obtained independently at Poona and Belgaum. The same methods were employed at both places. The rats were weighed immediately after death by chloroform, on a spring balance which was graduated to record five-gramme units. The observers had attempted to guess the weight to the nearest gramme, but it was plain from the way in which the fives and tens predominated among the records that such guessing could not be relied on. In arranging the figures, therefore, the following plan was adopted : Those numbers which ended in five or less were added to the ten group next below, while those which ended in six or more were added to the group above. A rat shown as weighing 75 gms. is placed in the seventy-gramme group, while another of 78 gms. is placed in the eighty group. It should be mentioned that the number of young within a pregnant female

rat can be counted with ease and without possibility of mistake, indeed the figures themselves are a proof of their own accuracy for the work was carried out at the two places by independent observers. In the tables the vertical column of figures on the left represents the approximate weights of the rats, the highest horizontal row of figures represents the number of the young which a female rat may carry, the other horizontal rows of figures show the numbers of rats of a particular weight which carry a particular number of young. Thus, in the case of table 1 the second row of figures shows that out of 1,003 rats which were examined, only 5 were nearly of fifty grammes weight, and that of these 3 carried five young, while the other 2 carried four and six respectively. It is plain that the rats of Poona are smaller than the rats of Belgaum, otherwise they resemble one another. Both races, if they should be called separate races, possess skulls of the *Mus rattus* type.

I.—*Observations made at Poona.*

Weight of the rats.	Number of the young.												Total of each array.
	1	2	3	4	5	6	7	8	9	10	11	12	
50 ..	..			1	3	1	..		..			..	5
60 ..	..	..	..	1	6	2		..		..	..	..	9
70 ..	..	..	2	10	17	12	4	..	1	..	..		46
80 ..	1	1	11	8	18	10	9	3	2	..		..	63
90	2	5	.7	18	30.	28	12	5	1	..	..	..	108
100	3.	5	10	25	37	35	21	7	2	1	..	..	146
110	1	4	12	19	38	37	29	6	2		..	..	148
120	2	6	9	21	36	26	30	14	6	..	1	..	151
130 ..	4	4	9	12	35	29	17	17	6	1	1	1	136
140	1	4	6	9	12	27	15	6	2	1	..	..	83
150 ..		3		2	13	11	6	6	2	..		..	43
160 ..	..	2		1	11	11	9	3	4	·.	..	..	41
170 ..	1		1	1	2	4	2	2	1	..	1		15
180 ..	..		1	1		2	2	2		..	..	..	8
190	..	..				..				1	..	..	1
TOTAL.	15	34	68	129	258	235	156	71	29	4	3	1	1003

II.—*Observations made at Belgaum.*

Weight of the rats.	Number of the young.										Total of each array.
	1	2	3	4	5	6	7	8	9	10	
70 ..	..	..	..	..	1	1	..	..	..	..	2
80 ..	..	..	..	10	7	5	3	..	..	..	25
90 ..	..	1	3	13	27	11	2	1	..	..	58
100 ..	2	1	1	18	43	23	14	3	..	..	105
110 ..	..	2	7	23	56	25	15	2	1	..	131
120 ..	2	2	7	23	54	40	23	1	3	..	155
130 ..	1	./.	5	18	46	30	16	4	4	..	124
140 ..	2	3	7	15	39	44	18	6	3	..	137
150 ..	..	1	5	20	41	38	10	3	1	1	120
160 ..	..	2	2	4	20	18	7	7	2	..	62
170 ..	..	1	1	4	14	12	9	2	1	..	44
180 ..	..	..	..	3	9	5	4	4	..	..	25
190 ..	..	..	..	1	2	4	1	1	..	..	9
200 ..	..	..	1	2	1	..	2	..	..	..	6
210 ..	..	..	..	..	..	..	3	..	..	..	3
TOTAL ..	7	13	39	154	360	256	127	34	15	1	1006

I think that the following conclusions are justified by the figures :—

(1) At Poona, mature female rats vary in weight from 50 to 190 gms., the mean weight being about 115 gms.

(2) At Belgaum, they vary from 70 to 210 gms. with a mean of about 125 gms.

(3) At both places, rats are more likely to bear five young at a time than any other number ; they may bear as few as one or as many as ten (at Belgaum) or twelve (at Poona).

(4) At both. places, rats which carry other than five young are more likely to have six young than any other number; they are more likely to have six than four. This is remarkable ; it is, however, shown not only by the aggregate figures *but by nearly all the separate arrays.*

(5) As regards their fertility the rats of Belgaum are somewhat less variable than those of Poona. Not only is the range of variation among the latter wider than among the former, but rats of average fertility are more common at Belgaum than at Poona. If the values for fertility be plotted in curves, that which represented the Belgaum rats would be steeper but less wide than that which represented the rats of Poona. Both curves would be unsymmetrical in the same way

(6) There is clear evidence that the largest and smallest rats are *quite as fertile as those of average size.*

(7) There is no evidence that large rats are particularly fertile at Belgaum, or that small rats are particularly

fertile at Poona, to account for the difference in size of the two local races.

In conclusion I must explain my indebtedness to Captain White and Captain Kunhardt who were in charge of the research measures at Belgaum and Poona. It is obvious that the statistics which I have made use of, could only have resulted from months of steady work. In this I took no part, being privileged merely to watch its progress during the few days of my visits to those places.