

of function to take place after nerve anastomosis is not due to a simple re-education process, as there is no evidence of this during recovery, but is probably due to an alteration in the centres under the influence of altered afferent impulses from the muscles, the brain thus having the capacity quickly to adapt itself to such alteration.

Variations in the Sex Ratio of Mus rattus Associated with an Unusual Mortality of Adult Females.

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At the commencement of June, 1911, whilst engaged on plague epidemiological observations in the United Provinces my attention was drawn to the fact that nearly all the young *Mus rattus* that were being trapped and examined by our staff in Lucknow were females. It was this strange phenomenon, the parallel of which I had never encountered during a five years' experience of plague research in India, that prompted the inquiry, the results of which are briefly set forth in this paper.

A few words explanatory of the methods employed in the daily routine examination of rats will show the nature of the material at my disposal. The prime object in trapping and examining large numbers of rats was, of course, to ascertain how far facts thus collected would assist us in solving the plague epidemiological problems with which we were faced. The species, sex, and weight in grammes of each rat caught were noted; the address of the house in which the rat was trapped and the number and species of fleas found on it were recorded. The sex of each rat was noted after dissection of the animal, and if it were female a further note was made as to the existence of pregnancy. If pregnant the number of fetuses was likewise written down. Finally, any pathological or other condition calling for comment was fully described.

All this information, which was in the first place recorded on cards, one card for each rat, was at the end of the day's work entered in a register. Weighing the rat was done in a specially constructed spring balance, by means of which the weight in grammes to the nearest multiple of 10 could be readily and accurately ascertained. I wish to emphasise the fact that the sex of the animal was noted only after dissection, so that

mistakes under this head were very unlikely to occur. A young female is not always easily differentiated from a young male by external inspection only.

Under ordinary circumstances *M. rattus* would appear to be slightly polygamous. Some observers have stated that it is very markedly so, and explain the fact that about equal numbers of males and females are usually caught by the alleged shyness of the adult female. This point I have carefully gone into and believe the allegation has no foundation in fact. As will be shown later, about equal numbers of males and females appear to be born under normal conditions. When adult age is reached there is either a somewhat enhanced mortality amongst males as compared with females or else males are more wary and so less readily caught. It should be noted also that females are as readily caught at the height of the breeding season as at other times.

In the presence of severe plague a condition of marked polygamy is sometimes met with. I believe this to be chiefly due to the fact that plague is a more fatal disease to male than to female rats.* When polygamy is marked rats are scarce or difficult to trap; on the other hand, when the rat population is very large the numbers of the two sexes trapped appear to be more nearly equal. In support of these statements Tables II-V have been produced.

(1) Ballia district: Here plague is always present and rats, probably in consequence, are very difficult to catch. Out of 4525 *M. rattus* caught during 10 months 2550 were females, a proportion of 77 males for every 100 females. If the rats be separated into two groups, young and adult, considering half the rats of 90 grm. and all those of lesser weight as young and the remainder as adults, the degree of polygamy prevailing amongst the rats of Ballia is seen to be even more marked than the above figures indicate. Of the 1875 young rats 943 were male and 932 female, whereas of the 2650 adult rats 1618 were female and only 1032 male. In other words, there were only 63 adult males for every 100 adult females (see Table V). The rats were obtained from places scattered all over the district.

(2) Coimbatore Town: Has suffered from repeated but not very severe epidemics of plague. *M. rattus* appears to be scarce; the catches were very small. Here of 3889 *M. rattus* 2072 were females, 88 females for every 100 males (see Table IV). Here again the excess of females over males affects adults only.

(3) Cawnpore: Here rats were extraordinarily numerous. When our observations started a mild epidemic of plague was drawing to a close. No acute rat plague was, however, met with. During the previous few years

* See 3rd Plague Report, 1907, 'Journ. Hygiene,' vol. 7, p. 750, and 7th Plague Report, 1912, 'Journ. Hygiene,' vol. 12, p. 265, Table VII.

the city had almost completely escaped plague, though in the more remote past its epidemics had been extremely severe. Our very high catches indicated a very large rat population and a complete recovery from the onslaughts of plague. In Cawnpore of 51,181 *M. rattus* examined in one year 25,838 were females, *i.e.*, 98 males for every 100 females (see Table II).

(4) Banda Town has never suffered from epidemic plague. *M. rattus* was present in very large numbers. In Banda of 10,127 rats caught during 11 months 5174 were females, *i.e.*, 96 males for every 100 females (see Table III).

In Lucknow, in which city the very abnormal conditions, fully described below, were present, of 34,908 *M. rattus* caught during the course of one year 18,396 were females, *i.e.*, 89 males for every 100 females (see Table I).

Disturbance in the Sex Ratio of M. rattus in Lucknow and its Readjustment.

A reference to Table I will indicate the nature of the phenomenon in Lucknow to which reference has been made. The table sets forth the weight frequency distribution of male and female *M. rattus* respectively for each of the 12 months from February, 1911, to January, 1912. There appears to have been some influence at work destroying adult females and sparing the males. This "influence" began its manifestations in March and produced its maximum effect in May and June.

As if to compensate for the apparently wholesale destruction of adult females, females only appear to have been born. These two processes, the destruction of females and the suppression of male births, proceeded *pari passu*. In June not a single male rat below the weight of 80 gm. was trapped, whereas 610 females of less weight than 80 gm. were caught. As the numbers of adults of the two sexes began to approximate more closely the one to the other, young male rats were again trapped in increasing numbers. In November, December, and January, the sex ratio approximated to that normally pertaining.

Such, in brief, are the facts; satisfactory explanations of the phenomenon are difficult to come by. It may possibly be advanced that in the above brief recapitulation of observed facts I have assumed more than the facts warrant. The objection that is most likely to be raised is to the assumption that failure to catch adult females signifies destruction of females. The shyness of the female might account for the phenomenon. This point has been referred to, and it was partly to meet this objection that I studied similar facts concerning 95,629 rats caught in various places. A reference to the tables of Cawnpore, Banda, Coimbatore, and Ballia rats will show that in no place other than Lucknow was such a circumstance observed. Female rats are not shy or

more difficult to catch than males ; on the contrary, it is possible that males are slightly more wary than females. As stated above the two sexes are normally produced in equal numbers, though adult females are usually in slight excess of adult males.

It may also be objected that the parallel assumption, that failure to catch young males signifies that no males are born, is not warranted by facts. This is admitted, but the only other explanation that I can offer is that the males were destroyed by their parents soon after birth (at a lesser weight than 10 gm., when it becomes just possible to trap them with the traps we employed, *i.e.*, at about a week old). That the parents should have destroyed only the male offspring is, to me, less easy of credence than that only females were produced.

It is a matter of regret that my observations did not succeed in throwing any light on the causes of the female mortality. Plague was certainly present until April, 1911, amongst the Lucknow rats, but it was not severe or widespread, and, as has been pointed out, plague is more fatal to the male than to the female. Whatever the cause was it was a widespread one in the city. The rats, caught from all parts of Lucknow, represented as fair a sample as could be obtained.

Further speculation on this interesting topic would not prove fruitful. The rapid readjustment of the sex ratio after so grave disturbance is, to my mind, the fact of chief interest. In May and June when hardly any females were produced there must have been an extreme degree of polyandry.

From a study of weight frequency curves of pregnant females, I have concluded that for practical purposes 90 gm. represents a fair dividing line between young and adult rats of Lucknow (Table VI). Half the rats of the weight of 90 gm. can be considered young and half adult. Employing this approximation, there appears to be an interesting correlation between the excess of adult males over adult females and the excess of young females over young males *for the same month*.*

In spite of the absence of any explanation of the facts the phenomenon described appears to me to be of sufficient interest to warrant its publication.

* Mr. Major Greenwood, Jr., Statistician to the Lister Institute, has kindly supplied me with the approximate correlations between the sex ratios of mature and immature rats for the same month and also for certain sequences. The groupings appear in Table VII and the coefficients in Table VIII. It will be seen that the negative correlation for data derived from one month's records is slightly larger than when the records of successive months are combined. A possible explanation is that overlapping of different affected colonies produces an apparent synchronism of cause and effect, but the figures as they stand do not warrant any inference. The enormous excess of young females in May and June is a statistically inexplicable fact.

Table III.—Banda, 1911-12.

M. rattus.

Weight in grms.	November.		December.		January.		February.		March.		April.		May.		June.		July.		August.		September (half).	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
11-20	19	10	10	7	0	1	6	10	9	10	33	24	46	19	54	40	49	39	28	26	16	15
21-30	39	28	4	3	10	10	16	16	44	38	66	44	47	52	32	28	32	25	27	26	24	18
31-40	28	33	6	11	6	7	16	18	30	28	59	38	34	18	17	26	35	19	12	27	18	23
41-50	49	43	18	11	5	9	20	13	31	24	38	29	26	18	25	26	31	26	21	21	15	15
51-60	50	59	17	20	17	11	8	13	20	18	29	24	27	22	21	21	32	16	25	20	24	11
61-70	76	94	21	26	24	38	5	15	21	20	29	24	27	27	16	26	18	29	22	36	27	19
71-80	88	102	35	48	28	49	10	27	20	39	15	18	27	29	9	20	32	42	24	24	27	24
81-90	79	98	38	49	25	42	23	32	19	16	8	12	13	14	9	20	15	26	22	20	15	10
91-100	92	109	45	58	44	68	39	65	31	30	14	31	10	19	13	16	25	47	19	36	12	24
101-110	70	103	39	61	58	67	39	67	22	40	14	41	17	18	18	22	22	37	20	31	11	12
111-120	90	102	47	64	44	98	55	86	36	59	14	48	12	24	10	24	22	44	20	37	13	18
121-130	74	84	33	34	68	77	59	70	33	51	22	38	10	24	9	23	14	37	20	37	13	18
131-140	50	62	33	34	49	33	56	31	33	30	14	17	10	10	9	6	15	13	25	25	13	12
141-150	38	40	37	34	30	12	48	30	40	36	22	28	10	10	10	3	16	15	13	22	9	11
151-160	24	19	10	9	30	18	38	12	31	22	20	12	8	4	5	3	11	12	13	13	9	5
161-170	38	7	20	4	25	4	24	7	22	13	8	5	12	3	5	3	7	2	9	8	7	3
171-180	24	4	10	2	17	1	11	5	15	10	11	4	4	2	2	2	6	1	6	2	8	0
181-190	18	2	9	1	14	2	17	—	9	—	7	—	1	—	3	—	11	2	1	2	5	2
191-200	8	1	9	—	1	3	17	—	0	—	3	—	1	—	—	—	2	1	1	2	3	—
201-210	1	1	1	—	—	—	4	—	3	—	2	—	—	—	—	—	—	—	—	—	—	—
211-220	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
221-230	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
231-240	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
241-250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
251-260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monthly totals	956	1001	445	476	529	550	515	517	486	485	422	443	337	320	278	310	383	409	339	412	251	251
	1957		921		1079		1032		971		865		659		588		802		751		502	
Grand total 10,127																						

In May and June about 150 "adult" rats were sent to Bombay. In the above table, therefore, the relationship between the numbers of young and adult rats is misleading. The proportion of the two sexes, however, was not appreciably affected by the proceeding.

Table IV.—Coimbatore.

Weight in grms.	January to March.		April to June.		July to September.	
	♂	♀	♂	♀	♂	♀
11-20	29	27	33	44	30	35
21-30	49	47	78	86	119	114
-40	62	43	50	51	72	74
-50	45	45	66	49	87	64
-60	32	33	48	48	76	78
-70	15	31	30	34	72	71
-80	18	30	29	49	52	66
-90	14	30	33	60	58	72
-100	11	36	51	63	46	94
-110	13	23	21	57	33	80
-120	14	32	31	59	52	83
-130	18	16	21	29	40	56
-140	9	11	23	15	37	38
-150	11	7	16	14	20	27
-160	6	2	18	11	28	9
-170	6	2	15	7	27	10
-180	6	0	9	0	15	5
-190	1	1	4	1	9	1
-200	1		1	1	3	1
-210	1				2	
-220	1				0	
-230						
-240						
-250						
Totals	362	416	577	678	878	978
	778		1255		1856	

Table V.—Ballia.—Consecutive rats caught between January 23 and October 6, 1911.

M. rattus.

Weight in grms.	♂	♀	Weight in grms.	♂	♀
11-20	102	82	160	74	142
21-30	182	171	170	67	89
-40	147	139	180	49	51
-50	127	135	190	51	34
-60	98	116	200	58	23
-70	127	109	210	34	9
-80	110	113	220	21	1
-90	100	134	230	4	2
-100	127	155	240	1	0
-110	89	168	250	0	0
-120	128	222	260	0	0
-130	102	248	270	0	0
-140	103	224	280	0	1
-150	74	182			

Table VI.—Lucknow.

M. rattus.

Weight in grms.	Number pregnant.	Number of females.	Per cent.	Number of foetuses.	Average.
51-60	6	1097	0.5	31	5.1
61-70	29	1026	2.8	135	4.6
-80	70	995	7	371	5.3
-90	120	917	13	614	5.1
-100	151	971	15.5	772	5.1
-110	200	968	20.6	1135	5.6
-120	303	1208	25	1670	5.5
-130	429	1648	26	2444	5.7
-140	423	1373	30.8	2509	5.9
-150	359	1034	34.7	2154	6
-160	292	778	37.5	1795	6.1
-170	305	678	44.8	2000	6.5
-180	134	279	48	856	6.4
-190	101	187	54	657	6.5
-200	40	80	50	272	6.8
-210	21	39	53.8	118	5.6
above 210	32	48	66.6	217	6.8

Table VII.

Weight in grms.	♂	♀	Total.
April.			
90 or less	106	561	667
Beyond 90	943	681	1624
	1049	1242	2291
May.			
90 or less	85	577	662
Beyond 90	1180	599	1779
	1265	1176	2441
March.			
90 or less	307	532	839
Beyond 90	984	948	1932
	1291	1480	2771

Weight in grms.	♂	♀	Total.
May-April.			
90 or less	85	577	662
Beyond 90	943	681	1624
	1028	1252	2286
May-March.			
90 or less	85	577	662
Beyond 90	984	948	1932
	1069	1525	2594
April-March.			
90 or less	106	561	667
Beyond 90	984	948	1932
	1090	1509	2599

Table VIII.

Source of Mature Rats (over 90 grm.).	Source of Immature Rats (90 grms. or less).	Coefficient of Correlation.*
March data	March data	-0.23 ± 0.04
April "	April "	-0.70 ± 0.02
May "	May "	-0.81 ± 0.01
April "	May "	-0.76 ± 0.02
March "	May "	-0.69 ± 0.02
March "	April "	-0.62 ± 0.02

* The coefficients were determined by means of Pearson's approximate method ('Phil. Trans.,' A, vol. 195, p. 16, equation lvii) and the probable error assumed to be $3[0.67449(1-r^2)/\sqrt{n}]$.

The Conduction of the Pulse Wave and the Measurement of Arterial Pressure.

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It is now well established that in cases of aortic regurgitation placed in the horizontal position the arterial pressure is considerably higher (50–80 mm. Hg) in the leg than in the arm.† Such pressures are taken by the sphygmomanometer, using the armlet method, the armlet being placed respectively round the calf and the upper arm, the disappearance and reappearance of the pulse wave being noted in the dorsalis pedis or posterior tibial artery, and in the radial.

In seeking for an explanation of this phenomenon it has already been suggested by us‡ that the "lability" of the arterial wall plays a considerable part, the term "lability" being used to designate the ease with which an artery distends with a rise and recoils with a fall of arterial pressure. The effect of increased and of diminished lability of the vessel wall upon the conduction of the pulse wave has been demonstrated schematically by

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† Hill, Flack, and Holtzmann, 'Heart,' vol. 1, p. 73 (1909); also Hill and Rowlands, 'Heart,' vol. 3, p. 222 (1912).

‡ Hill and Flack, 'Roy. Soc. Proc.,' B, vol. 86, p. 365.