# IX FURTHER OBSERVATIONS ON THE RACES OF INDIAN RATS

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In a recent number of the *Records of the Indian Museum* (vol. iii, pt. 1, 1909) I brought forward some evidence in favour of the opinion that discontinuous variation plays an all-important part in the production of new races. The observations on which this evidence was based were made upon some thousands of common house rats, which had been captured in many parts of India. The subject may be summarized as follows :—

It was found that the common house rats of India are, in a broad sense, of one species. It is not possible to find any sure criterion by which a house rat caught in the Punjab can be distinguished from one caught in Bombay or Bengal : but taken individually, the rats of any particular town are sometimes different from one another, especially in the kind and distribution of the pigment which determines their coat colour. Some of the differences, to which I refer, are of such magnitude that those specimens which exhibit them, can be distinguished from one another even at a distance of thirty yards in a good light. The common house rats of India are of the type long known by the name of *Mus rattus* ; they are usually of a dull brown colour which is somewhat lighter on the ventral surface.

In many Indian towns, thousands of house rats have been captured for sanitary purposes, and there is no doubt that the whole-coloured brown type is predominant. But sometimes other varieties are found along with the common kind. Of these other varieties, the commonest by far is one in which the fur of the whole ventral surface, of the belly, breast, throat and chin is pure white, the whiteness being sharply defined from the brown colour of the sides. Another less common variety is wholly black. In another variety the tail is partially white, in others there is a white patch on the forehead, or a white line on the breast.

The evidence for discontinuous evolution lies in the manner in which these varieties are distributed among the multitude of brown whole-coloured rats. In some towns, rats were caught in such large numbers that it was possible to ascertain the constitution of the rat population. It was found that the varieties occurred among the others in small groups, which were in some cases large enough to occupy two adjacent houses to the exclusion of other rats. The constitution and circumstances of some of these " family groups " was ascertained, but it was not possible to discover the method of their origin. It is an assumption to suppose

that these varieties appeared in the first case as the offspring of normal self-coloured parents; even if, as I believe, we are justified in making the assumption, there is no evidence to show whether the normal parents produced successive and entire litters of abnormal offspring, or an occasional "black sheep" from time to time. Judging from events which have been recorded from time to time it seems that the latter is the more likely supposition.

The following statement will illustrate the way in which the question often presented itself While in Madras City I had, during three days, the opportunity of seeing more than a thousand common house rats, and as a result of a somewhat cursory examination, I concluded that all were of the common brown whole-coloured type of *Mus rattus*; but from among them I picked out two which had a pure white line in the middle of the breast. The conclusion that one naturally jumps to is that these two, or their parents, or a near ancestor which showed the same peculiarity, must have been the offspring of normal parents. Although this conclusion is not supported by any actual evidence, it appears to be sound because we cannot find any other explanation.

But even if we regard their primary origin as uncertain, there is no shadow of doubt but that these abnormal rats sometimes occur in groups which may occupy two or more adjacent houses from which the normal rats have been displaced. It is this particular point which I wish to emphasize. The question was first placed beyond doubt in the case of the black variety of *Gunomys bengalensis* which was found in Rangoon. Twelve rats of this kind were caught in two adjacent houses, and no other rats of any kind entered the traps set in those houses during the time of their capture. It is certain that the black variety of *G. bengalensis* is not a common rat in Rangoon, and it has never been found except in Rangoon. During the year of my visit there, rats were being caught at the rate of four thousand a day. Before these twelve peculiar rats were captured, others like them had been brought very occasionally to the collecting stations, but it was not until nearly six months after the capture of the twelve, that two others were obtained. There is apparently no reason why these black rats should not have increased in numbers until they occupied ten or a hundred houses. Their success or failure would of course be decided in the stress of that competition which occurs among all living things.

Finally, there is a probability that established races such as are recognised by taxonomists as "good species" have arisen in the way indicated: because the characters upon which these species have been defined, are in some cases exactly the same as those which are found in the abnormal individuals or sports which occur along with the normal rats of India. For example, the character of albiventralism is a peculiarity of many well-known species of the *Mus rattus* group. A more striking example is presented by those species of rats in which the terminal third of the tail is white. The species *Mus blanfordi*, which is found in the hills of Madras, possesses this character, as do other species which have

been recorded from the Philippines. Rats possessing this same character have lately been met with in three separate parts of India. The circumstances of their capture show that they were not wandering members of an established race, but sports which have suddenly appeared among the common whole-coloured rats.

I have repeated the chief arguments of my last paper in a more decided manner: as it was said, perhaps with some truth, that they were indicated rather than expressed therein. Moreover, other observations have since been made which afford confirmation. These will now be dealt with.

### *Observations made at Poona.*

These are of special importance because of their accuracy Most of the rat-killing measures in India have been undertaken in order to prevent plague; to destroy the animals in large numbers has been the chief endeavour. But at Poona the destruction was carried out systematically by the Plague Commission, as an experiment. In the interval between the 26th May, 1908, and 22nd May of the following year, 45,487 rats were caught in Poona. They were not purchased indiscriminately from the town folk, but were captured in the following manner: Every night a large number of traps were set in certain houses of the town; each trap was labelled with the address of the house in which it was placed; next morning the traps were examined and those containing rats, in all to the number of 100 or more, were taken to the laboratory. Each rat then became the subject of various observations, which were recorded in a serial register. The points observed were those which might help the Commission in its task, such as the number of fleas on each rat, the pathological condition of the rat, the state of pregnancy, etc. For the biologist, it is most fortunate that any peculiarity of the outward appearance of the rats, as well as the place of residence of each one of them, were included among the records.

*Case* 1.—The house rats of Poona as a class have no special peculiarities; they are on the average slightly smaller than the rats of Bombay and some other cities; they are of the whole-coloured brown type, but are much less variable than those of Bombay City, where the black and the white-bellied varieties are comparatively common: indeed, they were almost of daily occurrence among the two or three hundred common rats which were being caught at that place. At Poona, however, among all the forty-five thousand rats which were caught during the year, there was not a single black one and there were only nineteen of the white-bellied variety. Of these nineteen I was able to obtain three, which were caught while I was at Poona. This was not due to chance, but to the fact that traps were specially set on my behalf in those houses from which white-bellied rats had previously been captured.

The white-bellied rats of Poona are exactly like the common ones, except for the one peculiar character which renders them

conspicuous ; so conspicuous are they among the others that it is the custom of the Plague Commissioners to refer to them for convenience as *Mus alexandrinus* as a nominal distinction from the common *Mus rattus*. This is in accordance with the modern use of the word "species," for two animals which appear different from one another at a glance are usually considered to be of different species. The name *M. alexandrinus*, as used in this particular case, might, however, be regarded by a systematist as calling for correction ; it is, therefore, preferable to use the term white-bellied variety. The map, plate x, shows exactly how far this variety is established in the city of Poona ; it must be remembered that forty-five thousand whole-coloured rats have been taken from the city at large and that there is scarcely a house which has not contributed to the total. The nineteen white-bellied rats were caught in nine houses ; four of these were contiguous and two others are separated from them by the width of a street. Six of the houses therefore form a distinct focus of habitation for rats of this special variety. The other three houses form another centre, perhaps more than one, which is situated about 250 yards further south.

The following table is an extract from the register and shows the order in which the rats were caught. The reality of the foci became gradually recognised as the trapping was continued in every part of the city.

| House. | Reference to map. | W. B. rats. |
|---|---|---|
| Raiwar 380 | 1 | 3 |
| ,, 338 | 2 | 2 |
| ,, 963 | 3 | 2 |
| ,, 1146 | 4 | 1 |
| ,, 1191 | 5 | 2 |
| ,, 553 | 6 | 2 |
| ,, 381 | 7 | 2 |
| ,, 382 | 8 | 3 |
| ,, 379 | 9 | 2 |
| | | 19 |

The serial numbers 1 to 9 refer to the order of capture of the rats and indicate the particular houses on the map. The focus which is represented by the six houses, 379—382, 553, 963, Raiwar, contributed fourteen rats, but this fact does not give us a true idea of the size of the colony;—if two or three rats are caught in a house their companions become wary and avoid the traps. In all probability this particular colony numbered a hundred or more individuals.

We therefore arrive at the following conclusions : Poona is a large town with a rat population of a million or more. The nature of this population has been fairly sampled by subtracting 45,000 of them from all parts of the city ; the rats are for the most part of the whole-coloured brown type, but established in the heart of the city is a colony of white-bellied rats which contains in all

probability a hundred or more individuals; this is inferred because six adjacent houses are known to contain them and, so far as could be ascertained, no others.

The question now arises as to how this state of affairs came about. The progenitors of the colony were either born in the city from normal parents or they are migrants of another race which arrived from without. In my opinion it is unnecessary to discuss the probability or possibility of the founders of the colony creeping unobserved into the heart of the town or arriving there in corn sacks, since we do not know whencesoever they can have come. There is no extensive area in India which is inhabited by a pure race of white-bellied rats. They are to be found in isolated groups side by side with the commoner whole-coloured rats in several parts of the Peninsula, especially in the south-eastern part of Madras, but there is no particular centre from which they can have migrated.

*Case* 2.—It was mentioned previously, that rats are occasionally found which are marked with a pure white line in the middle of the breast. The same kind of sport has been noticed in Bombay, Madras, Nowgong and Calcutta. At Poona I obtained four half-grown rats which were caught together in a trap. All of them have this breast mark, they are exactly in the same stage of adolescence and are obviously of the same litter; an adult rat showing the same character was caught in another trap close by. These rats are shown in the photograph, plate ix. This case helps to prove that, however such a character originates, it is passed on to all the members of a litter in the succeeding generations, and by analogy it helps us to understand how the group of white-bellied rats which were established in the six contiguous houses came into being. There is no apparent relation between the white breast mark, as a character unit, and albiventralism as such. Intermediate forms, showing a widening and lengthening of the breast line and bridging over the gap between the two extremes, were not found in Poona. In some parts of India, for example in Simla, rats have been found which are marked with variable patches of white on the abdomen (*ibid.*, pages 37, 38). The white breast line appears to be a definite character, not only among Indian rats, but among those of other countries. The species "*Mus hibernicus*" was established to commemorate a group of black rats which was found in Ireland. It has been shown that this species is a melanotic variety of *Mus decumanus* plus a white breast line. The published illustration of the skull of the Irish rat might indeed have been drawn from any *Mus decumanus* such as is common in Bombay and Calcutta. A white breast line occurs in animals other than rodents, for example in dogs.

*Naini Tal.*

A second visit to this place has enabled me to confirm the previous conclusions (*ibid.*, pages 38, 89), but in one respect to correct them. Since plague preventative measures were not in force a

Naini Tal, it was difficult to obtain the rats in large numbers, this state of things was a cause of error in one direction. The previous conclusions may be summarized as follows :—

(1) The rats of Naini Tal differ from those of the plains in the following respects :—

(*a*) they have on the average shorter tails ;

(*b*) their fur is longer and more plentiful and is of a greyer tint ;

(*c*) they are white-bellied, but a few of them are not quite pure in this respect ; in most of them every hair of the ventral surface is white in its whole length, as is usually the case in white-bellied rats ; but in a few of them the ventral hairs are light grey as regards the proximal half.

(2) A special class of rats was discovered in ten specimens which were caught in some adjacent buildings on Ayapata Hill. These are exactly the same as the others except as regards the colour of the tail. The tail of a rat is usually pigmented in its whole circumference, but in these the lower surface is pure white and devoid of all pigment, the upper surface is deeply pigmented in a variable area, in only one of them did it extend to the tip, in the others it extended to the middle of the length of the tail, in others not quite so far as this point, while in others it extended beyond it.

A second and more thorough investigation of the Naini Tal rats amply confirmed these first impressions, but showed that the range of the Ayapata race was much more extensive than was at first supposed ; but there is no doubt of the distinction between the two classes, nor is there any doubt that the distinction lies only in the colour of the tail. The enquiry into the relative distribution of the common or black-tailed class and the Ayapata class with the bicolored tails, which was carried out in May of last year, will now be dealt with. The result may be summarized as follows :—

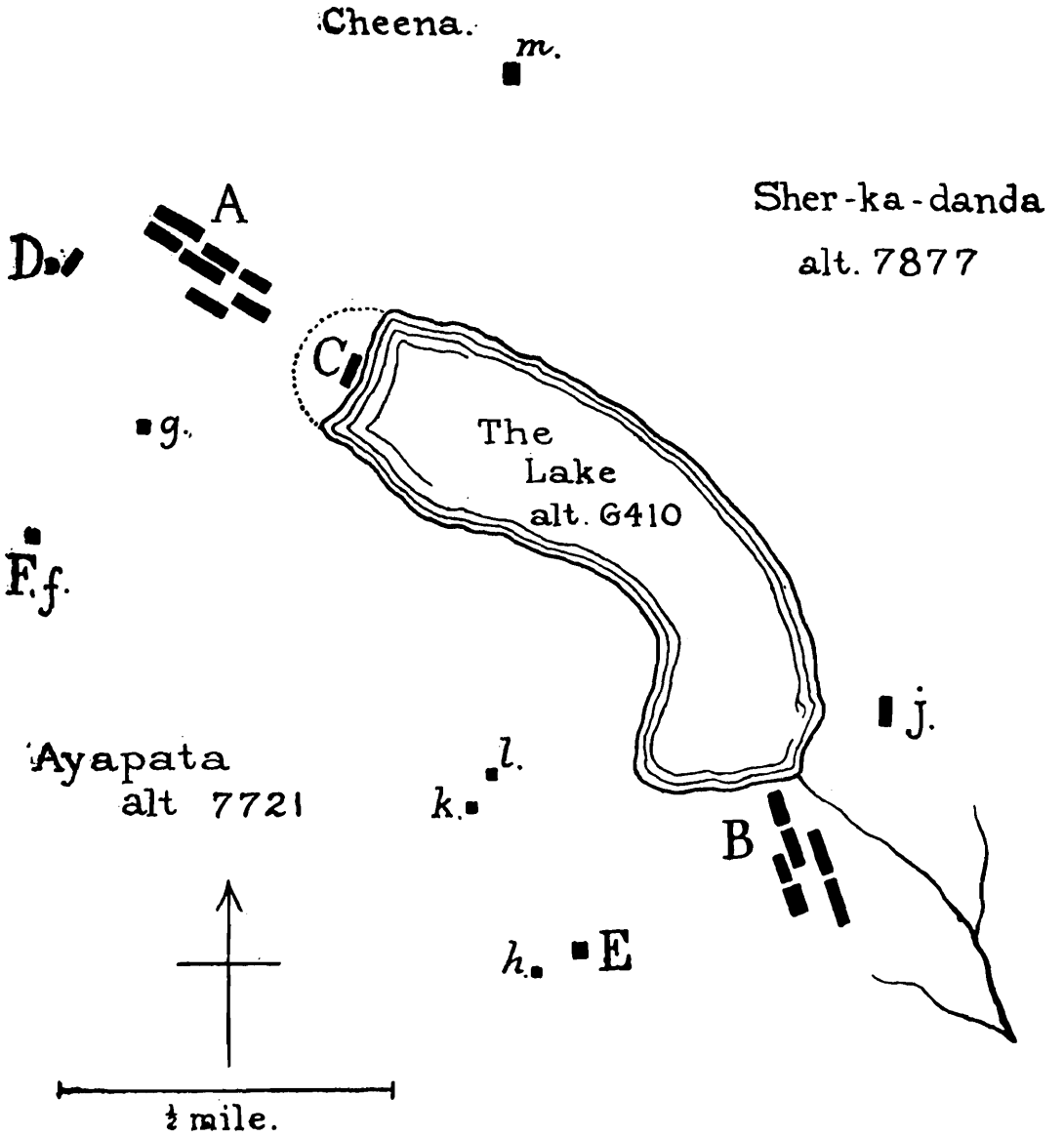
(1) Any one house contains rats of one or other kind, not of both ; there is one exception to this rule in the case of the house, Dalhousie Villa.

(2) The largest masses of buildings, such as the bazaars and shops which are situated at either end of the lake, contain black-tailed rats.

(3) Isolated buildings distant from and above the level of the lake generally contain white-tailed rats.

(4) But two buildings which are separated from one another by a few yards only may contain rats of the different kinds.

The distribution of the two kinds of rats in Naini Tal, so far as it has been ascertained, is shown in the following table which shows the numbers captured.




Map of Naini Tal showing places at which rats were caught.

| | Designation on map. | Black-tailed rats. | White-tailed. rats. |
|---|---|---|---|
| North Bazaar | A. | Many | 0 |
| South Bazaar | B. | Many | 0 |
| Assembly rooms | C. | 3 | 0 |
| Hotel Metropole | D. | 3 | 0 |
| Government House | E. | 1 | 0 |
| Dalhousie Villa | F.f. | 2 | 4 |
| Priory Lodge | g. | 0 | 4 |
| Sherwood | h. | 0 | 5 |
| Ramsay Hospital | j. | 0 | 1 |
| Ayapata House | k. | 0 | 7 |
| Derham House | l. | 0 | 3 |
| Old Govt. House | m. | 0 | 3 |

We can only speculate as to how this state of things came about. At the present day Naini Tal is a large cantonment lying among the Himalayas at an altitude of 6,500 feet; it communicates with the plains by a cart road about 30 miles in length; it contains some hundreds of well-built houses. The principal masses of buildings are the north and south bazaars, which are situated at either end of a lake. The lake is surrounded on all sides, except at its southern end, where it overflows toward the plains, by a circle of hills, the highest points of which, such as Cheena and Ayapata, are more than 1,000 feet above the level of the lake. Upon the inner slopes of these hills most of the larger houses are situated. Without detailed reference to the history of Naini Tal we may say briefly that practically the whole cantonment has come into being within the last hundred years. A century ago there was probably a small hamlet or two on the shores of the lake, the inhabitants of which held very occasional intercourse with the plainsmen. The rat population of Naini has grown to its present condition in even measure with the growth of the town. If we speculate as to how they came to be as we find them, we may perhaps be inclined to some such explanation as the following. The white-tailed race are the original inhabitants, but the black-tailed rats are invaders from the plains which have established themselves in the central parts of the town and forced the others to occupy the more distant outlying houses. It may be supposed that the daily arrival of carts carrying stores from the plains is sufficient to explain how the supposed invasion was effected. In my opinion however this invasion hypothesis may be rejected for the following reasons:—Both classes of the Naini rats resemble one another and differ from the lowland rats in the quality of their fur and in having shorter tails. The two classes of Naini rats differ from one another as classes in the colour of the tail only and in no other respect. Individual specimens of either class might be captured and produced as evidence to show that this is an erroneous statement, but an inspection of even as few as ten of each class would, I feel sure, convince most people that this statement is correct. The essential facts of the case as they appear to me are as follows:—

[1] (1) There are, living in the same limited area apparently under the same conditions, two classes of animals which differ from one another in one obvious character only.

(2) These two classes are segregative, *i.e.*, they live apart from one another.

If we enquire as to how this state of affairs came about, we shall best find the answer by considering the case of the white-bellied rats of Poona which differ from the common rats of that place in one character only (albiventralism) and are found apart from the common rats.

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[1] See *The Zoologist*, (3), xv, p. 1, January 1891.

If we examine the two classes of Naini rats strictly from the point of view afforded by the theory of gametic factors, we must suppose that the Ayapata class are not all exactly alike in their gametic constitution. For example, among the twenty-seven rats of this class, which have been caught, are two specimens in which the dorsal pigment of the tail extends to the tip. These are, as regards tail coloration, exactly like the well-known species *Mus vicerex* of Kashmir and several other species of other places. I have had the opportunity of examining at least twenty specimens of *M. vicerex*. The tails of all of them are exactly like these particular two of the Ayapata race. If we are to explain the facts in terms of the theory, we must suppose that these two differ from the others of the Ayapata race but resemble the rats of Kashmir as regards that part of their gametic constitution which determines the pigmentation of the tail. These two were caught along with others of the Ayapata race, and it is almost certain that they are closely related by birth to them (*ibid.*, page 40). The tail of one of these rats is shown on plate ix (second from above).

### *Comparison between Indian and English Rats.*

Through the kindness of the Curator of Zoology of the British Museum, I have had the opportunity of examining a brown and a black specimen of *Mus rattus* and a *Mus decumanus* which were caught in England. I can find no difference between them and Indian rats of the same species.

In conclusion, I must express my great obligations to Captain J. Kunhardt, I.M.S., who was in charge of the Plague investigations at Poona, and also to Colonel A. E. Ward for his kind help during my visit to Naini Tal.