I. THE RACES OF INDIAN RATS.

AN ENQUIRY SUPPLEMENTARY TO THE INVESTIGATION OF PLAGUE, AND DEALING WITH THE ORIGIN OF RACES FROM SPORTS.

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PREFATORY NOTE.

The collection on which Captain Lloyd's researches are based consists almost entirely of specimens sent to the Museum by medical and sanitary officers in India and Burma as a result of an appeal circulated by the Government of India in 1907. The history of this appeal is as follows:—At the time that Dr. W C. Hossack was engaged on the work embodied in his account of the rats of Calcutta, considerable discussion arose as to the species of rats which lived in association with man in different parts of the country. As the matter was an interesting one from every point of view, I wrote to the Board of Scientific Advice, asking the Board to bring to the notice of Government the importance of conducting a concerted survey of the rats of India. The Board forwarded my recommendations, with the result that the circular to which Captain Lloyd refers at the beginning of his paper was issued. Dr Hossack, however, found himself unable to continue his work on rats owing to the stress of other duties, and the Trustees of the Indian Museum failed in their attempt to secure the services of an expert mammalologist from Europe to deal with the collection of which the specimens presented to the Museum by Dr. Hossack formed the nucleus. The Trustees then approached the medical authorities with the suggestion that Captain Lloyd should be put on special duty in the Museum for this purpose. The medical authorities agreed, and Captain Lloyd's term of special duty, at first six months, was later extended to a year and then to eighteen months.

I venture to think that the Trustees' failure to secure the services of a specialist from Europe was not altogether a misfortune, although I was responsible for the suggestion in the first instance. Few zoologists would deny that an expert mammalologist with 2,000 rats before him, and only a year in which to work them out, would have been justified in devoting the whole of that time to a study of taxonomic minutiæ. A resident naturalist was,

however, in a different position. He was acquainted with local conditions and therefore able to start inquiring about doubtful points without the preliminary study necessary to a new-comer whose time in the country was limited. Perhaps, therefore, he was able to view the whole matter from a somewhat more biological point of view.

From a purely taxonomic point of view there are doubtless many zoologists who will find Captain Lloyd's work unsatisfactory, because he does not describe (or at any rate does not name) new species and varieties. It is perhaps as well, however, that animals so important as rats should not be regarded solely from either a taxonomic or a sanitary point of view, but that pure biology should have a place in their study.

Quite apart from the value of Captain Lloyd's researches, the importance of the collection of Indian rats that has now been got together in the Indian Museum must not be forgotten, and I desire, on behalf of the Trustees, to thank those who have assisted in this useful work. I have also to acknowledge a grant of Rs. 300, towards the cost of the plates which illustrate Captain Lloyd's paper, from the Home Department of the Government of India.

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INTRODUCTION.

In July, 1907, the Government of India issued a circular to the local Medical and Sanitary Departments in India and Burma, inviting them to co-operate with the Indian Museum in studying the varieties and habits of the common rats distributed throughout those countries. Such an enquiry is much needed at the present day in view of the part played by these rodents in the dissemination of plague. The circular met with considerable response, so that within the following year over two thousand rats were received by the Museum from different places.

Rat-destruction has been carried out on a large scale in many towns throughout the country, and it is chiefly from these centres that rats have been received. Most of them were obtained from districts in which plague has been of annual occurrence, but a number were received from places which have been free from the disease since the commencement of the present epidemic. Material has therefore been acquired by which we can compare plague-ridden districts with plague-free districts, as to the nature of their rat population. It is apparent that the freedom from plague enjoyed by certain districts might possibly be due to some visible peculiarity in the rat population of those districts; there

is some evidence that this is so in the case of Madras city. The distribution of the several species of common rats varies considerably throughout India; especially is this true of the principal sea-port towns. Dr. W. C. Hossack's investigation has shown that the rats of Calcutta city are surprisingly different from the rats of Bombay, which have been described in the reports of the Plague Commission. It will be shown that the rats of Rangoon and Madras cities are also different both from one another and from those of Calcutta and Bombay.

PREVIOUS WORK ON INDIAN RATS.

At the outset it must be pointed out that these results have followed directly on Dr. Hossack's investigation of the rats of Calcutta [1], and are in direct continuation of that work, to the author of which every acknowledgment is due, not only for the guidance afforded by the work itself but also for the results of his experience conveyed in a personal manner.

In an 'historical' paragraph Dr. Hossack reviews the previous writings on the subject of Oriental rats, and although it is unnecessary to repeat that statement here, it may be again mentioned that Mr. Thomas's paper [2], published in 1881, is the foundation on which any subsequent work on the subject must be built. The account of the rats in the *Fauna of British India* seems to have originated from this source.

As these observations are in continuation of Dr. Hossack's work, it does not seem necessary to again define the common Indian species of rats; it will be sufficient to say that they support the opinion that *Mus rattus*, the common rat of India, is, in colour and quality of fur, a most variable species, and that its variations are so numerous and seem to occur in such perfect gradation, when large numbers of specimens are examined, that definite varieties can rarely be established. It will be shown, however, that even in its range of variability *Mus rattus* is not constant throughout India. In some places there is a tendency for rats of this species to breed true to some particular type, while in others they exhibit a range of colour-variation as wide as that of the species in Calcutta (Hossack [1, pages 17 and 18]).

To name new varieties of the species seems unwise, for there is nothing to show that the rats which breed true to some particular type in a given district at the present day were in the same state fifty years ago, or will be found in a like condition fifty years hence. It must be remembered that one hundred generations of rats pass within the lifetime of one man. Moreover the following objection to the naming of varieties may be framed:—To establish a variety and lay down one specimen as its "type" is to acknowledge tacitly that all animals subsequently found from far and near which closely resemble that type must be genetically related to it. After examining large numbers of animals taken from widely separate localities, doubts arise as

to the validity of such an acknowledgment, and the probability that similar variations may arise in two separate localities appears very great.

In illustration of this the following example may be given:—The mole-rat *Gunomys bengalensis* was found to be common in Rangoon, occurring not only in granaries, warehouses and stables, but frequently in the rooms of dwelling-houses situated in the heart of the city. This rat, usually of a greyish brown tint, does not as a rule show much colour-variation. However, within the narrow limits of two adjacent houses, in a certain street in Rangoon, a number of pure black specimens were found. (This occurrence will be described in detail further on.) These may be regarded as a new variety which may or may not persist; but there seems to be no reason why a similar localized race should not appear in any other town in India. Indeed some evidence will be brought forward to show that melanotic mole-rats have arisen in two separate parts of Rangoon city itself, independently of one another.

Further, it can be shown that such peculiarities of colour-variation are by no means confined to the phenomenon of melanism. The following example may be quoted:—A race of white-bellied rats of the *Mus rattus* type was met with in Rangoon. The tails of these rats were uniformly dark greyish brown, being of exactly the same tint above and below. Among some hundreds of these rats which were examined, one was obtained which showed a pure white line along the lower surface of its tail,—in other words, the tail was obviously bicoloured. It appears that great stress is laid on this feature in defining species of rats; while it is admitted that within the limits of one species the lower surface of the body may be dark or pure white, the same admission is never extended to the tail. The following difficulty, therefore, presented itself:—Should this single specimen with the bicoloured tail be regarded as a separate species from the others which, except in the one respect, it so closely resembled? The probability that it was merely a sport from the common type appears too great for this step to be taken with any confidence. If now, it is granted that this particular specimen may have arisen as a sport, there appears to be no reason why, being prepotent, it might not have established a family with bicoloured tails within the limits of a few adjacent houses, as in the case of the melanotic *Gunomys*. Such a family would probably die out in a few months, but on the other hand, the strain might become firmly established as a new species.

These remarks have been made in order to explain the paucity of species and varieties recognised, and to defend the practice observed of not defining new species from single individuals or even from small local groups of individuals, which may show well-marked peculiarities of coloration. The literature of Oriental rats frequently reveals species, defined from three or four individuals caught within the narrow limits of a single house, all of which

agree in showing some slight peculiarity distinguishing them from other species. Whether it is possible to rediscover at a later date species defined in such a manner seems doubtful; and if it seemed possible, the question as to whether the individuals on which the rediscovery was alleged would be genetically related to those on which the species was originally defined, appears even more doubtful.

In the writer's opinion it is not possible to "classify" the Oriental rats in a satisfactory manner on the lines on which classification is being attempted at the present day. Before commencing systematic work in a group, the observer must make himself acquainted with the structural features which have been chosen by previous workers in defining new species. In the case of the *Mus rattus* group the following points are considered of sufficient weight to distinguish species: a difference of 30 mm. in "length"; a difference of 5 mm. in the length of the hind foot; of 3 mm. in ear-length; a difference of 20 in tail percentage; as regards colour, redness, yellowness or blackness are considered of importance; a white ventral surface is of some importance; a bicoloured tail (dark above, white below) is regarded as of the utmost importance. In 1903 Oriental rats were arranged in 96 species.

If, with these points well in mind, the observer examines 500 rats caught in different parts of an eastern town and attempts to classify them, he is confronted with an impossibility. (I do not refer to mole-rats, bandicoots and *Mus decumanus*, which are distinct at a glance.) He finds that variation among the heterogeneous collection is wide enough to embrace all, or nearly all, the points chosen by previous writers on which to define species; but he also finds that ten rats caught in the same house will often resemble one another very closely in colour, size, and proportion, always more closely than ten rats taken haphazard from different parts of the town. The rats of two separate houses will sometimes show differences as great as those chosen to distinguish species, while the rats in each house resemble one another very closely indeed. The following difficulty therefore presents itself. Should any or all of these small groups receive specific names?

The common procedure which leads to the definition of a new species of Oriental rat seems to be as follows:—

'A field naturalist sets traps in a rat-frequented house or close to a set of burrows in a field; two or three house or field rats are caught; in either case the specimens which closely resemble one another come into the hands of a specialist in Europe, who examines them regarding such features as those enumerated above. Although they resemble one another very closely, it is highly improbable that they will, in every way, closely resemble any previously described species. They are defined as a new species. The discovery of new species on these lines is slow because the number of rats examined is quite insignificant when compared with the number of rats present in one Oriental town. Though slow, the process cannot end.

The definition of such species, however burdensome it may seem, is not in itself fallacious, for a family group of inbred rats taken from a single house or set of burrows may show definite and measurable .peculiarities. By naming these groups specifically one does not directly establish a fallacy. Indirectly, however, the procedure causes false impressions, in the following way. When a new species is discovered in a district, the discovery being based on a few specimens caught together, the idea is originated that many other rats in that district will resemble the type of the new species. This is far from being the case. The species of Himalayan rats illustrate this anomaly. From previous writings the impression is given that *Mus jerdoni* is a common rat in Darjiling; that *Mus niveiventer* is common in Katmandu; that *Mus vicerex* [3] is the rat found at Simla. We have received rats from six different parts of Darjiling, none of which resemble *M jerdoni* in any way; over fifty rats are from Simla, none of which show the peculiarities of *M. vicerex.* Rats brought this year from Katmandu have no resemblance to *M. niveiventer* which was described in 1836 from five rats caught in the Residency of that place. On the other hand, certain rats from Kashmir are very like the type of *M. vicerex*, judging from the description of it. Certain rats from Naini Tal are equally like *M niveiventer*, though one of these was caught in the same cupboard on the same night with a rat which showed features peculiar to *M. berdmorei* [4], a species only known from Manipur (Assam), and Mergui (Tenasserim). It seems impossible to reconcile results obtained by studying large numbers of rats with results which have been previously obtained by the study of small numbers of specimens.

Great confusion exists in the nomenclature of Oriental rats. The common mole-rat of India was first regarded as a species of *Mus*; later on it was known as *Nesokia bengalensis*; quite recently it has become a species of a new genus *Gunomys* [5]. The antelope rats may be placed in the genera *Meriones*, *Tatera* or *Gerbillus*. Specific names which have been long abolished are often revived. As a result of this it is often difficult to determine the scientific names of common rats.

The following instance may be quoted in illustration of this difficulty. The honorary curator of a local museum sent certain field rats to the Indian Museum for identification. They were returned as *Nesokia hardwickei* and *Gerbillus erythura*. The sender, being desirous of obtaining the best possible results for his museum, sent similar specimens to Europe; they were returned as *Nesokia huttoni* and *Meriones erythrura*. The Indian Museum was informed of this by the curator of the local museum. It cannot, however, be maintained that one pair of names was right and the other wrong. The names given by the Indian Museum for these well-known rats were taken from the *Fauna of British India*, the author of which upholds the name *Gerbillus*, and considers that the specific name *huttoni* is included in *hardwickei*.

Confusion of nomenclature among the group is increasing at the present day. Two new species, *Mus listoni* and *Mus comberi*, have been recently added to the list of Indian rats [6]. In the words of their discoverer "There is little to distinguish *listoni* from *mettada* except the difference in the size of the molars, but this difference is quite constant and easily appreciable even by the naked eye." It seems to be noteworthy that specific differences in an animal so large as a rat should be appreciable even by the naked eye. *Mus comberi* was discovered among eight rats collected at Nasik, four of which were identified as *Mus mettada*, the remaining four being regarded as of the new species. The measurement of the molar series of these specimens is given in millimetres as 5·6, 5·7, 5·7, 5·7; 6, 6, 6·1, 6·2. Those with molar series measuring 5·6—5·7 formed the new species *Mus comberi*. Those from 6—6·2 were regarded as *Mus mettada*. As regards these dimensions, the difference between the largest and smallest in *mettada* is ·2 mm. The difference between the smallest in *mettada* and the largest in *comberi* is ·3 mm. There is *no other difference* between the two species, which live together in Nasik. Anyone who accepts the separation of these two species must suppose that among any thousand "Mettads" from the Nasik district, a very small proportion will possess molar series measuring 5·8 and 5·9 mm.; he must further suppose that a "Mettad" with molar series measuring 5·7 mm. will recognise and refuse to mate with one whose series measures 6 mm., lest mongrel offspring with series of 5·8 and 5·9 be born. After reflecting on the smallness of the dimension represented by ·1 mm., and the impossibility of measuring it by means of ordinary appliances, it is difficult to regard these two suppositions as well founded.

Mus listoni was defined from five specimens from the Konkan; it is separated from *mettada* for the same reason that *Mus comberi* was separated, because the teeth are some three-tenths of a millimetre less than in *mettada*.

Mus listoni and *comberi* are separated because the latter is "distinctly smaller" and for no other reason. The author of these new species gives the dimensions as follows:—

Head and body length in millimetres.

Mus comberi (4 adult females)	118	119	120	125
Mus mettada (3 ,, ,,)	122	122	127	
Mus listoni (2 ,, ,,)	132	134		

The same author continues: "The specific separation of *comberi* and *listoni*, however, must depend on the non-existence of intermediates (*i.e.*, in size); from my knowledge of the country I argue that the discovery of such is most unlikely, and I have not hesitated, therefore, to rank them both as species."

On examining the measurements we see that the difference between the largest and the smallest *comberi* is 7 mm., and that the difference between the smallest *listoni* and the largest *comberi* is also 7 mm. Why, then, is it necessary to seek further for "intermediates"? In one case a difference of 7 mm. in length between two individual rats is not considered sufficient to separate them as species, while in the case of another pair of rats a precisely similar difference is the sole reason given for separating them.

Introductory statements must be made regarding the way in which the subject has been dealt with in this paper.

HOUSE RATS (*Mus rattus*).

It will be found that the house rats from each place, if received in large numbers, have been sorted into groups according to their lengths, the numbers in each group being represented graphically by an upright line of proportionate length. This method has been much used by biologists of recent years. It is generally applied to large numbers of accurate measurements. In the present instance it will be seen that the numbers that have been so arranged are often not large, nor can the measurements be very accurate. The measurements here recorded are of the distance between the centre of the anus and the tip of the nose in freshly killed rats. If a careful observer measures and records this length in ten freshly killed rats, and, without referring to the first record, repeats the measurement two or more times, he will find that his records do not agree, if the bodies of the rats are disturbed in any way (as by being lifted and replaced on the table) between each set of measurements. The differences observed may be as wide as five millimetres. The error is principally due to the varying attitude of the head and neck. In taking the measurement the head must be straightened, but not stretched from the neck. In his efforts to perform this the recorder arrives at a different result each time. Hence we are dealing with a dimension which cannot be accurately measured. This error contravenes in measuring the limp bodies of rats immediately after their death. If a rat is measured two or three hours after death when the neck is shortened and the spine curved by *rigor mortis*, it may have lost as much as 10 % of its original length. In this case the recorder, while measuring a large rat, is in doubt as to whether 10 mm. or 20 mm. should be added by stretching out the body.

However, as the measurements of different observers must be marred by these accidents by an equal degree, it is clear that a comparison of them must be of value.

Although the sets of measurements were made by different observers working quite independently, they show a striking resemblance to one another. They show that the adult house rats of most districts vary in length from less than 145 mm. to more than 215 mm., but that those of 175—185 mm. are the most numerous. As the same result is obtained from such widely separated districts

as Amritsar, Allahabad, Nowgong, Tellicherri and Calcutta, we must conclude that they form one class throughout, although great individual differences of colour, size and proportion can be noticed among the rats of any one place, and in spite of the fact that the rats of one place may collectively show certain peculiarities of colour and sometimes of proportions. Until recently it was thought that two varieties of the species were to be met with on the plains of India, a large northern variety (*alexandrinus*), measuring about six inches in length, and a smaller southern variety (*rufescens*). It seems that this idea should now be abandoned.

Reference must be made to the skulls of the rats of this group. It has been mentioned before that over ninety species of rats have been described from the Oriental region which are, indisputably, closely allied to *Mus rattus*. From the definitions of most of these species one learns that each of them has its own peculiar type of skull, the nasals are of a particular length or shape, the auditory bullæ are exceptionally small or unusually inflated, the infraorbital foramen is more open below, the zygomatic plate may form a prominent angle or it may not, the frontoparietal suture is in some a widely open angle, in others it is less obtuse. However small they may be, the skull of each species has its own peculiarities.

But it seems to the writer that in most cases these differences are such as can be readily found among any thousand skulls of rats taken from any town in India. Some of these specific types of skulls have been carefully figured. A comparison of these figures with skulls selected from among large numbers of rats of any district, confirms this opinion. There is, however, a considerable range of variation. Small adult rats as well as young rats differ considerably from large adults in the proportions of their skulls. It will be shown that local groups of rats taken from a single house may have skulls which are very closely alike, all agreeing in that they are distant from the mean of the race to an approximately equal extent.

The differences between the skull types of most of the species of Oriental rats fall within the range of variation exhibited by a small number of rats from one town. This is proved by measurements already published.

For the sake of brevity the writer has dealt only with measurements of the four most important features which are usually recorded in "types" of the species of *Mus*. These features are the greatest or zygomatic breadth of the skull, the length of the nasal bones, and the lengths of the palatine foramen and upper molar series. The measurements have been expressed as percentages of the greatest length of the skull. These features have been chosen because it is in them that the more distinct forms, *Mus mettada*, *Mus decumanus*, *Gunomys*, *Nesokia* and *Bandicota*, differ from one another and from the type of *Mus rattus*.

A standard for comparison is afforded by Hossack's measurements of forty-five skulls of Calcutta house rats of all sizes and of the *Mus rattus* type.

Measurements of forty-five skulls of Mus rattus *from Calcutta.*

	Length.	Breadth.	Nasals.	Pal. for.	Molars.
Maximum.	100	52·5	41·09	21·2	19
Minimum	,,	46·9	32·5	16·2	15·1
Range		5·6	8·59	5	3·9

Measurements of skulls of "types" or co-types of various species of Indian Rats (W L. Sclater).

Species.	Length.	Breadth.	Nasals.	Pal. for.	Molars.
M. rufescens	100	52	38	18	18
M. fulvescens	,,	53	43	17	19
M. blanfordi	,,		42	22	20
M. nitidus	,,	51	38	18	18
M bowersi	,,	..	40	17	17
M. berdmorei	,,	53	40	19	21
Range		2	5	5	4

These figures show that the "types" of six distinct species together show a smaller range of variation than forty-five chance-taken rats from one town. Sclater's records are, as a whole, higher than Hossack's. This must be because in measuring the total length of the skulls the former did not include the incisor teeth; consequently the percentage values of the other features were slightly raised.

In the skulls from Calcutta the palatine foramen is sometimes greater, sometimes less, than the molar series. *Mus mettada*, *Mus decumanus*, and perhaps *Mus jerdoni* have their own skull types and so are excluded.

Species of rats from other parts of the Oriental region do not usually show wider variation in the proportion of their skulls than those presented by Hossack's measurements.

The measurements of three species from the Malay region will be given; they have not been specially selected but are of the three new species of *Mus* recently discovered in that region.

Measurements of skulls of "types" of Malay species (Bonhote).

Species.	Length.	Breadth.	Nasals.	Pal. for.	Molars.
M. bukit ..	100	48	40	16	17
M. jalorensis	,,	47	35	17	17
M. griseiventer	,,	45	35	16	16
Range	.	3	5	1	1

As regards these measurements, therefore, the three Malay species also fall within the range of variation exhibited by the rats of Calcutta.

A number of species have recently been described from the Andamans. Measurements of the "types" of these show a similar range of variation, if examined in the same way.

Measurements of skulls of "types" of species from the Andamans (G. S. Miller).

Species.	Length.	Breadth.	Nasals.	Pal. for.	Molars.
M. flebilis	100	44	40	19	16
M. pulliventer	,,	49	36	18	18
M. burrus	,,	46	37	18	16
M. burrulus ..	,,	49	36		17
M. burrescens	,,	49	36	..	17
Range	.	5	4	1	2

With the exception of the breadth in *M. flebilis* and *burrus* these measurements are all within the range of variation exhibited by the forty-five Calcutta rats.

The new species *M. stoicus* and *taciturnus* from the Andamans, are short-tailed rats of large size, not of the *rattus* type, and have therefore been excluded.

As regards these important measurements the "types" of all these species scarcely exhibit a wider range of variation than that shown by forty-five *Mus rattus* taken from a single town. It is not likely that the smaller details such as the shape of the nasal bones, zygomatic plates, tympanic bullæ, and the like, will be of value as distinguishing marks of races. The skulls of fifty rats taken from

different parts of any town show very great variation in these minor points; at the same time it must be admitted that a few rats caught in a single house, will often show striking similarity to one another as regards these details.

THE MOLE-RATS.

When the mole-rats and bandicoots of India were first examined by naturalists, the different groups among them received such names as *Mus kok*, *Arvicola bengalensis*, *Nesokia indica*, *Mus plurimammis*, *Mus giganteus*, *Mus bandicota*. In 1878 J. Anderson [10] united them as a sub-genus of *Mus* under the name *Mus* (*Nesokia*), and pointed out the indisputable fact that the group could be subdivided into three series. In 1907 O. Thomas [5] applied a separate generic name to each of these three series, *viz.*—

Nesokia for mole-rats which have a short palatine foramen, a tail which is only about 50 % of the head and body length, and few mammæ.

Gunomys for mole-rats which have a long palatine foramen, a tail which is about 80 % of the head and body length, and a continuous row of teats from the axilla to the inguinal region.

Bandicota for the very large, coarse-furred rats known as "bandicoots," which have a relatively longer skull than the others, a tail nearly equal to the head and body length, and relatively large feet.

Anyone who examines large numbers of these rats must recognise the marked discontinuity between the three groups, and the only objection that can be brought against their receiving generic rank is, that there is no greater difference between them than there is between other groups of small rodents which receive merely specific rank. For example, the difference between a *Gunomys* and a *Nesokia* seems even less, it is certainly not greater, than the difference between *Mus rattus* and *Mus mettada*. In spite of this objection the triple generic nomenclature is used here.

Gunomys (*Nesokia bengalensis*) has been received from the Punjab, Calcutta, Rangoon, Madras, Simla, Nepal and other places.

Nesokia (*Nesokia hardwickéi*) only from Quetta and the Punjab.

Bandicota from Madras, Bengal and Nepal.

Although a large number of specimens from any one place always show considerable variation among themselves, there are noticeable differences between the races from several of the places. As these differences seem to be approximately equivalent to those which separate the races of mankind inhabiting the same regions, they have not been considered of sufficient weight to justify the application of specific names. Current literature shows that to honour local races with specific names is becoming a

custom at the present day, when the species of twenty years ago rank as genera, and new species must be found.

Within the last few months a revision of the genera *Gunomys*, *Nesokia* and *Bandicota* has been published [11], including several new species. As the specific characters are founded on the measurements of chance-taken "types," it is impossible to identify our specimens by means of this classification. The difficulty of attempting to do so may be briefly expressed. In this new classification nine species of *Gunomys* are recognised. They are divided into two series, A with upper molars less in length than 7·5 mm., B with upper molars greater than 7·5 mm.

The length of the upper molars in twenty mature specimens of *Gunomys* from Calcutta—presumably *G. bengalensis*—vary from 6·5 to 8 mm. (Hossack). The measurements of the molar series in the types of the nine species of *Gunomys* are, according to this new classification, as follows: Series A, 6·6, 6·8, 7·2, 7·6, 7·8; Series B, 8, 8, 8·3, 8·3. We see therefore that as regards the length of the molars, which is so important a character that it is used in the grouping of the species, twenty chance-taken specimens from Calcutta include no less than seven out of the nine Oriental species of the genus. The skulls from which Hossack's measurements were taken are preserved in the Indian Museum; the accuracy of the measurements cannot be questioned.

On the average the *Gunomys* of the Punjab certainly have larger teeth than the *Gunomys* of Bengal, but the measurements given in the new classification are of chance-taken "types," and variation among the rats of any district is so wide that none of the characters quoted can be relied upon for identification. The only reliable datum is the name of the district from which the "types" were obtained. We know from this that our specimens from Kashmir and Nepal are *G. wardi* and *tarayensis*, respectively. If this method is permissible identification is easy, but the number of species must be large.

It is unfortunate that the author of this classification did not consult Hossack's work; if he had done so he would have avoided the error of supposing that the *Gunomys* of Bengal measures 205 mm. in length. Hossack's measurements of fifty specimens from Calcutta show that the length of this species varies from 160 to 205 mm., with a mean of 182. Specimens measuring over 200 mm can be found only with difficulty.

MEASUREMENTS AND DEFINITIONS.

Before passing to the descriptive portion certain terms must be defined—

1. By the length of a rat is meant the combined length of its head and body, *i.e.*, the distance between the snout and anus; the difficulty of measuring it accurately has been already mentioned. For the sake of brevity measurements have been recorded without

explanation, but always in this particular order: Length, tail length, length of hind foot (from heel to longest toe, excluding the claw), length of ear (the greatest length). In this way the measurement of a common rat would be shown as 175, 200, 30, 20.

2. By the length of a skull is meant the distance from the condyles to that part of the premaxillæ which projects between the incisor teeth. The molar series has been measured at the roots of the teeth where they spring from the sockets. In measuring skulls, ·5 mm. has been usually regarded as the indivisible unit. This seems rather a coarse method, but it was found, when the unit was ·25 mm., that measurements of the same skull, taken by two careful observers, did not often agree. Some workers split the millimetre into ten equal parts; they accomplish this feat presumably by using ordinarily well made dividing compasses, the points of which together rarely measure less than ·3 mm. They are recommended to repeat the measurements of one skull day after day, and to observe the variety of the results obtained.

3. The term "new character" is used here to denote particular characters which are only present in some few members of a race,—for example, about one in every thousand rats has a white-tipped tail. This was noticed in *Mus rattus*, *Mus concolor*, *Gunomys* and *Bandicota*. The phenomenon of a white-tipped tail is spoken of as a new character. Occasionally this particular character is common. Several *Mus concolor* from one district show it. Other examples of new characters are melanism, albinism, albiventralism and caudal bicoloration. There is an undoubted similarity in the method of occurrence of these characters among rats, hence one term is applied to them. A rat showing a new character is a sport, though some sports show more than one such character. By a white-bellied rat is meant one in which the belly, chest, throat, lower jaw, and the inner side of the limbs is covered with pure white fur; this character is very common among Oriental rats.

4. The term "family group" has been frequently used. It was found that the rats of one house were always more closely alike than an equal number of rats taken from different houses in the same town; this is not surprising, but it was sometimes found that the rats from one house or set of burrows were very closely alike, not only in colour, but in proportion of body and skull, and that they were collectively different from the mean of the mixed race of which they formed a part. Rats showing new characters

such as melanism, etc., commonly occur in family groups. A family group may be defined as a small part of a community the members of which resemble one another very closely, so that the mean of their characters is different from the mean of the characters in the general community. Family groups probably arise owing to prepotency and inbreeding. The term "clan" may be suitably applied to them. A family group is originally a small community; it may, however, become a large one: it is then a race. That a very small community may become a large one, despite inbreeding, was shown by the Australian rabbits.-

These statements appear somewhat didactic; they are of course merely brief expressions of the writer's opinion. (See Appendix II.)

5. The word type is used by me in two senses. By the type of a species is meant an imaginary individual which embodies the mean characters of the species. By "type" of a species is meant the arbitrarily chosen type specimen which is laid down for reference in some place, like a standard of measurement.

6. The word species has many different shades of meaning; it must however be used in referring to systematic literature. A number of rats which closely resemble one another and form a discontinuous group has been generally spoken of as a race.

SYSTEMATIC DESCRIPTION ACCORDING TO REGIONS.

THE PUNJAB.

Owing to the energy of Captain G. I. Davys, I.M.S., it has been possible to investigate the rats of the Punjab in a most satisfactory manner. Although strenuously engaged on plague duty, he has contrived to send us over 1,000 rats with careful measurements of each. This large collection has been received in the form of skins, including skulls, tails and feet, preserved in spirit. To each skin is attached a metal plate referring to the measurements, which were taken immediately after death by chloroform. This is a very convenient method of transporting large numbers of rats; on arrival they can, if desired, be set up as dried specimens in the conventional state in which small mammals are usually found in museums. The colour of the fur is not altered by the brief immersion in spirit.

Among house rats, we have received 513 of the *Mus rattus* type from fifty villages in the Amritsar district, 105 rats of the same type from Lyallpur, and 55 white-bellied rats from three specified villages. In addition, we have received records of the

weight of 3,000 rats of this type, and large numbers of skins of field rats of different species.

Pjb. 1, *Mus rattus*—

Of the 513 rats of this type, 100 were carefully examined regarding the following points: Texture of the fur, presence or absence of spines, length of bristles, colour of fur, forms of foot

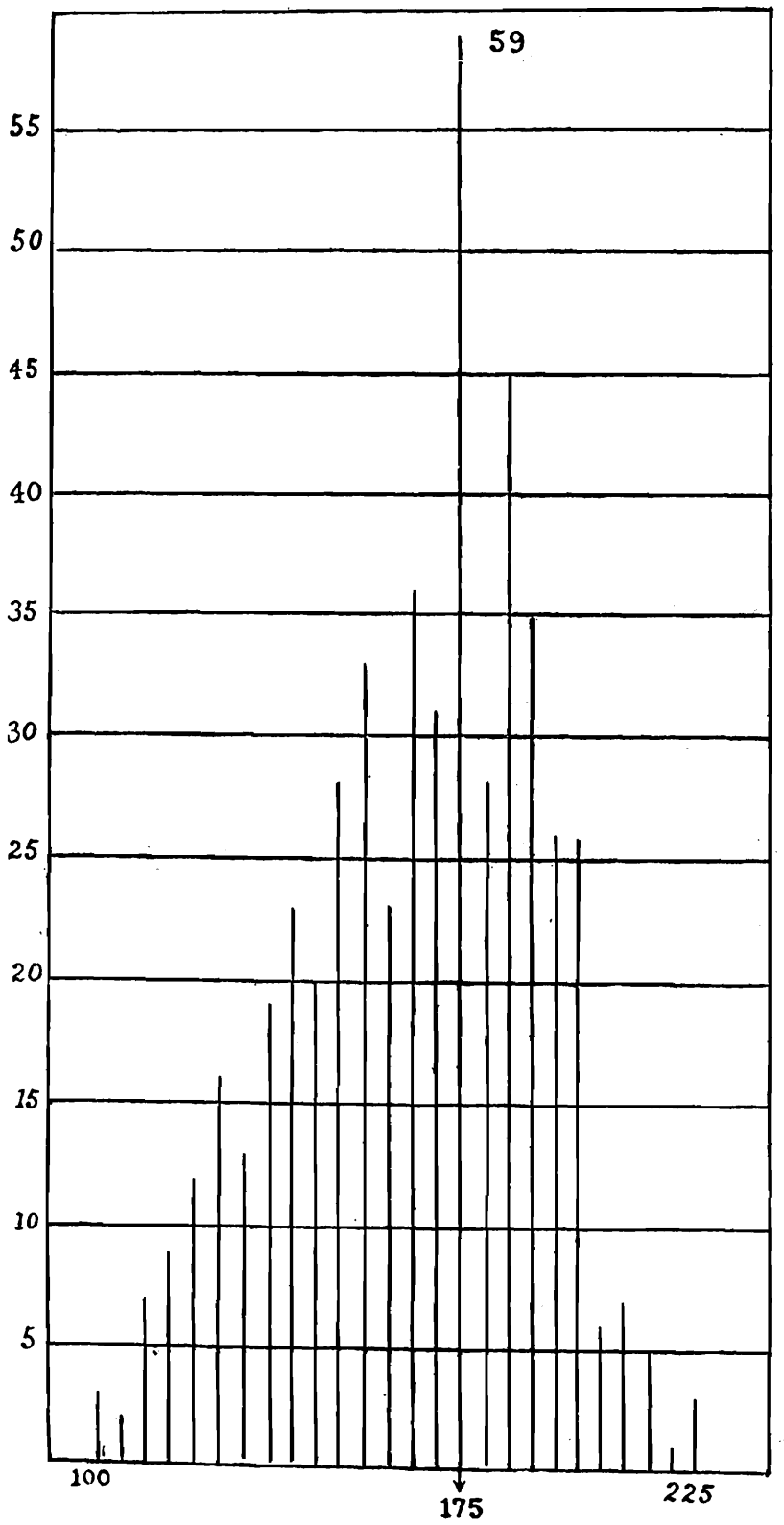

FIG. 1.—Diagram showing the length-frequency of 513 *Mus rattus* from Amritsar (Davys).

pads, number of palatal ridges, number of rings on the toes, length of hair on the tail, and its relation to the length of the scales, difference in colour of the hair above and below the tail, the number of teats, relative proportions of the skull. Where possible, these features were measured, but the measurements will not be recorded here as they show no useful results. Except for the number of palatal ridges, all these points were found to vary within wide or narrow limits. But deviation from the normal in any one character was not regularly associated with deviation in any other character. The group seemed to form one race. That they are one race is shown by the large series of measurements of lengths. The measurements, which were recorded in millimetres, were arranged in a series of ascending values. The numbers of rats of each length were added together, so that the whole collection became resolved into a series of groups, all the rats of a particular length forming one group. As the collection contained adult rats the lengths of which were as low as 140 mm., and as high as 225, every intermediate value between these extremes being met with, the number of the groups was large. The number was divided by 5, by contraction upon every 5th group. For example, the numbers of rats measuring 153, 154, 156 and 157 mm. were added to the number which measured 155. Those measuring 158, 159, 161 and 162 mm. were added to those measuring 160 mm. The results are shown in a diagram (text-fig. 1) in which the horizontal lines show the lengths in an ascending series, from the left, and the vertical lines indicate the numbers of rats of, or closely approximating to, each length. The diagram shows that rats of about 175 mm. form a majority, that this value is approximately the mean length of the race, and that the numbers of rats of each length become fewer as their lengths become further removed from the mean. It shows, however, that individuals 225 mm. in length can be found and that they are clearly of the same race as those of 180 mm.

It must be pointed out that in constructing the diagram a large number of immature individuals have been included. Their presence accounts for the wider range below the mean than above it, which the diagram exhibits. It is well known that in any character capable of measurement, a group of related organisms shows equal deviation from the mean, both above and below it. We can infer therefore that, since there are at least three individuals of 225 mm. length (*i.e.*, 45 mm. greater than the mean), there must be a small number of mature individuals 135 mm. in length or thereabouts, and that the range in the length of the race is not less than 90 mm. Examination of rats of about 140 mm. length shows that some of them have the 3rd molar worn, and this is usually considered a sign of maturity. No doubt can be thrown on the maturity of a certain small specimen—R. S. No. 674—which measures 140, 155, 28, 14 mm., and weighs 65 gms., the 3rd molar being well worn. The specimen has been sent in spirit complete, so as to show that the uterus contains two embryos in an advanced stage of development.

As the immature have not been excluded, there must be some among those measuring 175 mm. which are not mature; if these had been removed the mean would be raised. Therefore, the mean shown in the diagram is somewhat lower than the true adult mean. The immature were included owing to the difficulty of saying whether many of the smaller individuals were mature or not. It is highly probable that some of the specimens measuring 140 to 150 mm., in which the third molar is cut and even slightly worn, have not stopped growing. Because of this, it was thought best to include the measurements of all specimens received, and this has been done not only in the case of the Punjab rats, but in the case of all house rats from other places when they have been received in sufficient numbers.

These measurements show that the house rats of the Punjab hardly differ in length from the rats of Calcutta. Hossack's measurements of ninety *Mus rattus* afford the only standard available for comparison. The measurements of other writers are of "types." Hossack found pregnant rats of between 140 and 150 mm. length, while among the ninety are six rats of over 190 mm. length; he states and repeats the statement "gradation of size is simply one of age." It is possible that his meaning is not expressed fully; as it stands it is obviously erroneous. A man of six feet four is not always very old; moreover, Hossack's published figures contradict his statement, for while the ninety rats contain only six individuals between 190—200, there are nine between 180—190, and twenty between 170—180. These results are similar to those obtained for *Mus rattus* in other parts of India, and if arranged would show a similar diagram.

The 500 measurements from the Punjab show that adult rats vary from (about) 140 to 225. This is not evidence that the Punjab race is larger than the Calcutta race, as the measurements were taken in a slightly different way in the two cases; moreover, they are of 500 Punjab rats and 90 Calcutta rats. However, it would not be a matter for surprise if the Punjab rats were somewhat larger. The results of length measurements obtained from such different places as the Punjab and Calcutta are therefore approximately the same. They will be compared with those from other parts of India.

Tail length.—There is some evidence that the mean of the tail length in Punjab rats is less than that of the Calcutta race, also that in the Punjab there are groups of rats in which this value is exceptionally low. At first sight Captain Davys's measurements show surprising differences from those of the Calcutta race. Many are shown as having the tail length less than the length. This is partly due to the fact that the measurements were recorded by Davys from the first ring of the tail, and not from the anus. On repeating some of the measurements, but from the anus to tail tip after brief immersion in spirit, it was found that the new values obtained were all about 7 mm. more than those of Davys's records. The difference of course varied with the size of the rat. In order to equalize the Calcutta

and Punjab measurements, 10 mm. was added to the tail length and subtracted from the length in the latter series; even after this very liberal allowance had been made, the difference between the Punjab and Calcutta race is very apparent. Hossack's measurements show that the mean tail length of the Calcutta race averages 125 % of the length. As mentioned before, the Punjab collection was received in batches of about twenty individuals, each batch being collected on a different date and often from a separate village. After making the allowance of ± 10 mm., the average tail percentages of the groups vary from about 115 to 120. One or two exceptional batches, however, show lower values. Lot D. C. shows the lowest of all.

Lot B. R.			Lot L. T.			Lot D. C.		
Length.	Tail.	Percentage.	Length.	Tail.	Percentage.	Length.	Tail.	Percentage.
184	210	113	160	194	121	186	215	115
165	191	115	176	205	117	172	194	113
175	190	108	170	190	111	174	190	109
193	215	111	170	208	122	175	196	112
160	190	118	182	215	118	184	213	116
175	198	113	162	191	118	169	196	116
177	214	120	172	213	123	177	204	115
171	194	123	170	206	121	177	184	104
			164	205	125	177	184	104
			165	194	117	164	183	111
						165	175	106
						169	179	106
Average		115·1	Average		119·3	Average		110·6

The measurements were all taken by the same hand, all individuals received in each batch were included except those the length of which was less than 160. Small and young rats were excluded, because the ± allowance of 10 mm. would fall too heavily upon them; and because young rats have proportionately longer tails than adults (Hossack). Among the different batches from the Punjab, the Lot L. T. shows one of the highest average tail percentages; Lot D. C. the lowest. The average percentage of all the 500 was not calculated, as it would not accurately represent the value in the whole race. It must be about 117

The writer considers that the above figures show firstly, that the tail percentage of mixed Punjab rats is lower than the same value in Calcutta rats; secondly, that as regards tail length the Punjab rats are not a thoroughly mixed race. The great difference

in this value shown by Lots L. T. and D. C. can only be explained by supposing that the rats were taken from groups the members of which had collectively different tail lengths.

In the proportions of hind feet and ears the Punjab race does not seem to differ from the Calcutta race.

Colour.—As regards colour the Punjab rats are peculiar in one respect. They are less variable than the rats of many other parts of India. Among many thousands, not one melanotic form was met with. Those that were received by the Museum were in spirit, so that fine differences in colour could not be easily appreciated. A considerable number of them were washed and dried; in these the coloured element of the fur was always of a reddish brown tint. The occurrence of white-bellied forms in the Punjab is of particular interest.

Pjb. 2, *the white-bellied race*—

The Museum had been receiving rats from the Punjab for some months without obtaining a single example of the white-bellied type. Because of the recent observations on the rats of Calcutta, it was thought to be one of the attributes of the species *Mus rattus* to produce white-bellied forms occasionally, and yet although the rats that were arriving from the Punjab were exactly like many of the Calcutta race, there were no white-bellied ones among them. Consequently Captain Davys was addressed on the subject. He replied that although he had often met with rats having pale coloured under parts, he had never, in the Punjab, seen a pure white-bellied rat like those he had previously noticed in Simla, which were as white below as a *Gerbillus*.

Later on, however, a few white-bellied rats were sent from the Punjab, and finally a considerable number of them. Davys paid special attention to the subject, and found that they could always be obtained from three particular villages out of the sixty-nine over which his operations extended. The other villages only contained the dark-bellied type. The three particular villages are not adjacent, one of them is in the Lahore district. As the question is important from more than one point of view (see pages 85, 92) the list will be quoted as we have received it. The rat-catching measures in the Punjab will doubtless be continued, so that it will be possible to confirm or modify the statement at a later date.

AMRITSAR DISTRICT.

Dhoniyia Kalan	300	Kaonke	300
Mode	1,000	Bhadyiar	200
Atari	400	Mahwa (or Mahawa)	2,000
Ruranwala	600	Bagyiarian	100
Dhande	1,000	Galluwala	200
Ranike	200	Raja Tal	2,000
Rangarh	400	Bhaini	1,000
Neshta	100	Doake	600

Baropal	500
Bakna Kalan	88
Bakna Khurd	187
Her	57
Hoshiarnagar	215
Achinkot	87
Lahori Mal	100
Chicha	123
Mahmudnagar	300
Nahtupura	400
Khera	81
Jahtawal	300
Maluwal	132
Lahedwala	100
Gharinda	45
Nowshéra Dhala	800
Kasel	300
Dhand	159
Adelewala	227
Manj	83
Miran Kot	435
Nurpur	18
Madali Guru	93
Raja Sansi	235
Sarangdeo	16
Chak Misri Khan	280
Pundori Waraich	253
Wairka	470
Kamalpur	17
Khaparkheri	412
Sangatpura	21
Isapur	16
Kheron	427
Tarantaran	50
Ibban	124
Chatiwind	117
Mehta	50
Loharka	248
Othian	58
Bhullar	75
Karyial	110
None	78
Kakkar	44
Chabalmannan	107
Deo	205
Makanwind	117
LAHORE DISTRICT.	
Kila Jiwan Singh	355
Thaipura	238
Bhanuckah	127
JULLUNDUR DISTRICT.	
Kartarpur ..	78
Honian	23
LYALLPUR DISTRICT.	
Lyallpur	111
AMRITSAR CITY	2,786
	22,590

Some of the high numbers are approximations.

The three villages Addelewala, Nowshera Dhala and Kila Jiwan Singh contained white-bellied rats to the extent of about 10 % of the total number caught. The diagram, text-fig. 2, shows that these white-bellied rats scarcely differ in size from the common type. The

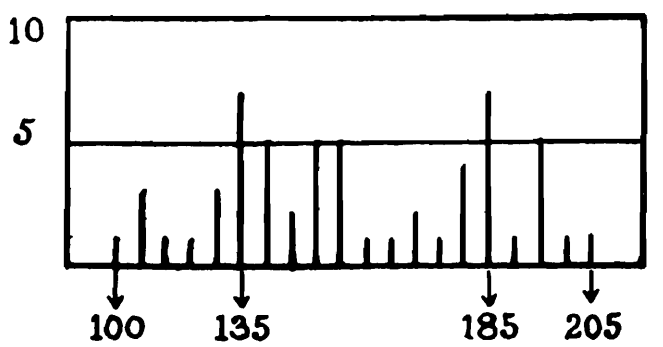

FIG. 2.—Diagram showing the length-frequency of 55 white-bellied *Mus rattus* from the Amritsar district (Davys).

irregularity of the diagram is due to the large number of young ones included. The adult maximum is indicated at 180—185 mm., which seems somewhat high.

The tail proportion was calculated in twenty adults; after making the ±10 mm. correction it is found to vary from 127 % to 102 % with average of 115·3 %. This is low for the Punjab; much lower than the proportion shown by the Calcutta race. The skulls of these white-bellied rats were not found to differ from those of the common Punjab race, which do not seem to differ from the mixed Calcutta race in this respect. These rats are not all of the pure white-bellied type; many of them have a coloured stripe in the middle of the breast; they resemble the Simla race (Sml. 2) in this and all other respects.

Pjb. 3, "*Mus brahminicus*"—

Among the house rats sent by Davys were two of exceptional interest. These resemble one another almost exactly but differ from the common race in more than one respect. They both have a well-marked white star on the forehead, and the terminal third of the tail is pure white. These features are shown in plate i. The sender alluded to them tentatively as a new species "Mus brahminicus" (so called from the "caste mark" on the forehead); and there is no doubt that their peculiarities are better marked than those of many species of the *Mus rattus* group. Since at least twenty-two thousand house rats not showing these peculiarities were captured in the district from which these two were obtained, one cannot regard the pair as part of an established race.

The writer supposes them to be part of a "family group" of sports exactly comparable to the groups Rng. 8 and Ntl. 2. Such groups are too limited in their membership at present to be dignified by the term "race"; however they must each have some slender chance, varying directly with their fitness, of becoming a race.

The measurements of these rats, recorded by the sender, are as follows:—

163	172	31	14	85 grms.
163	167	29	13	95 grms.

they are both of a much lighter colour than the average Punjab rat, their under parts are white, both were certainly adult, the female was pregnant (four embryos). Besides resembling one another closely and differing widely from the average rat in colour, they resemble one another closely in length and weight and differ from the mean length (180 mm.) and mean weight (140 grms.) of the Punjab race.

This pair of sports is biologically of the utmost interest. The most noticeable peculiarity which they exihibit is the absence of pigment from the terminal third of the tail. The change from the pigmented portion to the unpigmented is very sudden, so that one scale possesses its full complement and the next is totally devoid of pigment. The change was so sudden that it called to mind

the human disease leucoderma; it was, however, felt to be impossible to explain these extraordinary rats as pathological freaks, for the two resemble one another not only in their tails but also in the forehead star, in size, and in the light brown colour of the coat.

Seven species of rats have been recorded from Celebes and the Philippines, in all of which the distal third of the tail is devoid of pigment. They have received the names *Mus xanthurus*, *celebensis*, *meyeri*, *everetti*, *macleari*, *luzonicus*; together they form the "*Xanthurus* group" [8]. There seems, therefore, little doubt that rats showing this peculiarity are an established race in that part of the world. They must be as variable as the rats of India, for when met with they have, more often than not, received a different specific name. If the figure of the tail shown on plate i be compared with the illustration of the tail of *Mus macleari* shown on plate xii, *P.Z.S.*, 1887, no difference can be seen in the appearance of the two appendages. One cannot escape from the conclusion that the character, terminal caudal albinism, which is evidently the mark of a successful race in the neighbourhood of the Philippines, has arisen in the Punjab quite independently on this occasion and probably on many other occasions, in many other places. These sports can not be explained as reversions. Even if one makes the absurd supposition that the *Xanthurus* group represents the parent stock of the Punjab rats, the latter race must be separated from the former by a vast number of generations, for nearly two generations of rats pass in one year.

Pjb. 4, *a Mus rattus with a white-tipped and tufted tail*—

The last centimetre of the tail of this rat and the hair upon it are white. The white hair is usually long and projects 6 mm. beyond the fleshy tip. This case is perhaps of small importance; similar sports were noticed among the rats of Calcutta; they are especially common among *Mus concolor*. The same character has been noticed in *Gunomys* and *Bandicota*. This case is mentioned because of the concomitant lengthening of the hair. As the case of Pjb. 3 recalls the *Xanthurus* group of the Philippines, so in a lesser degree does this case recall *Mus blanfordi* of the Nilgiri Hills (Madras), the principal feature of which is a tail white in its distal half with lengthening of the terminal hairs.

Pjb. 5, *Gunomys sp.*—

No less than 157 rats of this species have been sent by Davys from fields in the Amritsar district. They resemble one another in having a tail proportion of about 75 %, a hind foot proportion of about 17 %. Their skulls are short and broad, and can be recognised at a glance from those of all other rats. Their skulls, however, resemble those of the newly defined genus *Nesokia*, except that in that genus the incisor teeth are broader and the palatine foramen is concomitantly much shorter than in *Gunomys*. (plate iii). The female *Gunomys* has a continuous row of teats on either side,

and produces about ten young at a birth. They form a concrete group sharply defined from all others; in deference to the latest nomenclature they are spoken of as *Gunomys*. They were long known as *Nesokia bengalensis*.

From the collection eighty-five specimens have been selected as undoubted adults, and these alone have been examined in detail. The actual lengths of the specimens are shown on plate v. They vary from 173—235 mm., and form a continuous and almost unbroken series. The line of dots is flatter in the middle and steeper at the ends, individuals of mediocre length being in the majority. Over half the total number are between 192 and 207 mm. in length. The five individuals above 230 mm., which are somewhat separated from the others, are all large males; there is no evidence that they are a separate race because of their size. The percentage of tail length in the length of each individual is shown by the zigzag *At.* which varies from 60—83 with an average of 70 or a little over. The length of their hind feet is shown by the line *Af.*; it is on an average about 16 % of the length.

Comparing these with Hossack's measurements of fifty mole-rats of Calcutta, we see that the Punjab mole-rat is somewhat larger than the Calcutta one. The slight difference in the tail and foot percentages may be explained by the different way in which the measurements were taken in the two cases (see page 18). The difference in length, however, seems too great to be explained in this way.

Fifty Calcutta mole-rats, "Nesokia bengalensis."

	Minimum.	Maximum.	Average of 50.
Length	150	205	182
Tail percentage	69	91	81·1
Foot percentage	15	19	17·4

In the character of the fur the Punjab race differs considerably from the Calcutta race, so that it would be almost always possible to recognise individual specimens from either place, among a mixed collection. One cannot, however, describe a Punjab type, as there is great variation among the specimens. Two individuals will be described: Specimen T. N. X. 3, a large female measuring 200, 133, 32, 12; specimen K. R. S. 3, a large male measuring 210, 158, 34, 10.

Up to a certain point one description will suffice for both. The colour of the two animals is alike, and in general terms may be described as dark greyish brown above, passing gradually into light grey below. The hairs which compose the dorsal fur are in both animals about 2 cm. long, the basal two-thirds of each hair being of the colour of a dark slate, the apical third being of a particular

shade of light brown nearly the same in both cases. The ventral surfaces are covered with shorter hairs each of which is grey with a fawn-coloured tip. In spite of these similarities the two specimens can be distinguished from one another with the greatest ease by passing the finger tips through the dorsal fur. In the female specimen the fur is soft and silky, indistinguishable from that of a *Nesokia hardwickei*, which almost equals prepared sealskin in softness. The fur of the male is harsh and bristly to the touch, because some of the hairs are of much greater girth than the majority and are pointed and stiff; others again are as long as 6 cm., of a black colour, and project far beyond the majority. In technical terms the fur of the male rat should be described as consisting of soft under fur, short spines and long bristles, while the female specimen would be described as being totally devoid of spines or bristles. Between these two extremes the eighty-five specimens show every intermediate grade. The difference is to a certain extent a sexual one, for the whole collection does not show a single adult male specimen of the extreme soft-furred type. But although females are often soft-furred, some of them possess bristles and spines. There is no evidence that there is more than one race among the collection. However, an examination of groups of mole-rats from separate colonies or sets of burrows would doubtless show that the rats of some groups were collectively of the soft-furred type, while other groups would be more of the opposite type.

It is generally easy to distinguish a *Gunomys* of the Punjab from one of Calcutta. The soft sleek-furred type has not been met with in Calcutta. The mole-rats of the latter place always have harsh and bristly fur, soft under fur being scanty. Although in the Punjab rats bristles and spines are usually present, soft under fur is also plentiful in every case. Calcutta mole-rats are generally of a cold dark greyish brown colour, Punjab ones being of a warmer and lighter brown, not infrequently of a reddish tint.

The skulls of the *Gunomys* from the Punjab resemble those from Calcutta, except that the molar series (and perhaps the palatine foramen) is on the average longer in the Punjab race. This is apparent to the eye as well as capable of being measured. It is, however, easy to find individual exceptions.

The following are the measurements of five chance-taken skulls from a mixed collection from the Punjab:—

Length.	Breadth.	Nasals.	Pal. for.	Molars.
42·5	25	12	9	9
100	58	28	21	21
40	25·5	12·5	9	9
100	62	31	22	22
38	23·5	11	9	8
100	61·8	29	23	21
43·5	26·5	12	9	9
100	61	28	20	20
45	27	14	10	9·5
100	60	31	22	21

Twenty Calcutta Gunomys (*Hossack*).

	Length.	Breadth.	Nasals.	Pal. for.	Molars.
Max. percentage	100	63·3	28·2	17·5	16·2
Min. percentage	100	58·2	31·8	22·9	19·7
Average ,,	100	59·8	29·3	19·2	18

The *Gunomys* of the Punjab and of Bengal are clearly of a different race.

Pjb. 6, *Nesokia sp.*—

We have received forty-five rats of this species from the Amritsar district. They were found living in the same part of the district and in precisely the same state as the *Gunomys*, but members of the two genera were always occupying separate colonies. The occurrence of these two genera, living side by side, is biologically interesting from more than one point of view. Incidentally it illustrates the modern meaning of the word "genus" as applied to mammals: the separation of the genera *Nesokia* and *Gunomys* was made by an eminent systematist [5]. When large numbers of specimens from the Punjab belonging to both genera are mixed together, it is difficult to separate them by their outward appearance. In colour and quality of the fur, members of the two genera are often indistinguishable; this is not surprising, as they are all found

burrowing in the same sort of soil. All the *Nesokiæ* have soft sleek fur, but some of the *Gunomys* resemble them in this respect. If a sleek *Gunomys* is placed in contact with a *Nesokia* so that the fur of both intermingle, the resemblance between the two is sometimes so great that not one point of difference can be appreciated. The members of both genera are variable in colour but in the same way. Those specimens of *Gunomys* which have harsh bristly fur can, of course, be readily distinguished from the soft-furred *Nesokia*; but because some of the *Gunomys* are sleek, a mixture of the two races cannot be readily separated by the appearance of the fur. In length the *Nesokiæ* vary from 134—186 mm.; the *Gunomys* from 163—236; length is therefore of less value than colour in effecting a separation. From a record of tail percentages of the two genera, presented in the diagrammatic form shown on plate v, it might be thought that this character provided a means of distinguishing the two races; however, the diagram shows that the *Nesokia* with the longest tail, and the *Gunomys* with the shortest, both have a tail percentage of 60, and the whole series of percentages range continuously from 49—83. The foot is of no more use than the tail in identifying individuals of the two races. In the Museum the two are distinguishable at a glance, for *Nesokia* has a very short palatine foramen and broad incisor teeth (plate iii). The difference between the two races must have been difficult to recognise in the field.

Captain Davys, however, noticed when opening the burrows of mole-rats that they either contained small litters of young ones (two to four) or large litters (eight to twelve); he also noticed that the rats found in the former kind of burrow were usually smaller and had relatively shorter tails than those found in the latter. It was afterwards observed that females of the one race had few teats—almost invariably two pectoral and two inguinal pairs—while those of the other race had a continuous row of about eight on either side. The difference in the number of the teats has long been known and led to the latter race receiving the generic name of *Gunomys* (the fruitful rat), the former retaining the name of *Nesokia*.

The difference between the apparent fertility of these two races is amazing when we consider that they are living side by side in neighbouring fields. If the *Nesokia* were the more fertile race, we should of course triumphantly point to this power as an explanation of the fact that the small race was able to live in competition with the larger *Gunomys*. It is, however, the *Gunomys* which appears to be two or three times more fertile than the *Nesokia*.

The lengths of all the undoubted adults received, twenty-four specimens in all, are shown on plate v; they vary in length from 134—197 mm. It happens by chance that these twenty-four specimens show about the same range of variation in length as exhibited by the eighty-five *Gunomys*. If many more *Nesokiæ* had been measured it is not likely that the range of variation would have become much extended. The measurements of *Mus rattus*, *Mus concolor*,

Nesokia and *Gunomys* all show that the range of variation in length is about 40 % of the mean length; the same is probably true of all small mammals. This is not usually admitted by systematists at the present day, although in 1871 J A. Allen measured the length of twenty-eight adult squirrels and found that this comparatively small number exhibited a range of over 20 % of the mean [12].

In the case of *Nesokia*, however, there is considerable evidence that a pigmy race has arisen or is arising in a certain part of the Amritsar district. Some families of *Nesokia* were sent from a field near the village of Atari; these included four adults. In length these four measure 146, 147, 151, 155 mm., that is to say, they are all well below the mean. The similarity of the skulls of these four is remarkable.

The pigmy which measures 134 mm. is, however, from another part of the district. It was specially sent by Davys as it was pregnant, bearing two embryos. The third molars of this specimen are well worn down. Its maturity cannot be questioned.

Plate ii shows a series of seven *Nesokiæ* selected from the twenty-three to show gradation in length. Beneath them are shown the skulls of the same seven specimens. These skulls exhibit not only a difference in size, but a difference in form, for in the two marked S. B. B. 1 and S. B. B. 18 the ridges which mark the upper limit of the temporal muscles are visible but not prominent, and are set widely apart. In the skull P. C. M. 2 these ridges are more prominent and much closer together; this is the skull of the largest *Nesokia* we have received. The rats designated S. B. B. are the small ones from Atari already mentioned. Other skulls are intermediate in form as well as size between the two extremes. The measurements given below show how the small skulls resemble one another and differ from the larger ones in the proportions of the molar teeth.

The bodily proportions of *Nesokia* are shown on plate v. The percentage of the tail length in the length varies from 49 to 60, with an average of about 54. The discontinuity of the two genera is clear; there is not the slightest upward tendency in the line of the tail proportion (*Bt.*) shown by the largest *Nesokia*, although as regards length the two races overlap by a wide margin. The percentage of the hind foot is between 17 and 18, or about 1 % higher than in *Gunomys*, but in this character there is a distinct downward tendency in the line shown by the largest specimens (*Bf.*).

The skull of a *Nesokia* is easily distinguishable from that of a *Gunomys* owing to the abbreviating of the palatine foramen. The two races are quite discontinuous as regards this character, although they both show considerable variation (plate iii). Although this is the most obvious difference between the two types, it is not the essential one. The teeth, both incisors and molars, are much larger in *Nesokia* than in *Gunomys*. We can therefore see a reason for the abbreviation of the palatine foramen which has obviously been caused by the closing of the posterior half of that space. A

smaller skull being called upon to support more massive teeth responded by half closing its palatine foramen. On either side of the groove which indicates the closure is a bony eminence encroaching on the groove; if these eminences are opened the roots of the incisor teeth are discovered. The difference between the teeth of the two genera is great. In the smallest *Nesokia* (length 134 mm.) the incisors together measure 4 mm. in breadth. In one of the smallest *Gunomys* (length 165) it is only 3 mm. The measurements of the molar series are shown below. Even among the *Nesokiæ* themselves it is seen that the smallest skulls have the largest teeth not only relatively, but actually. A skull 42 mm. in length has a molar series of 7·5 mm. A skull of 35·5 mm. has molars of 9 mm. These are extreme cases. The difference in the appearance of the two skulls is striking. The skulls of *Gunomys* both from the Punjab and Calcutta do not, however, show the same tendency.

Measurements of ten skulls of Nesokiæ *from Amritsar.*

Designation.	Length.	Breadth.	Nasals.	Pal. for.	Molars.
A. T. W 3	35	24	9·5	3·5	8
	100	68	27	10	23
S. B. B. 1	35	23·5	10·5	4·5	8
	100	67	30	13	23
S. B. B. 19	35 5	24·5	10	4	9
	100	69	28	11	25
S. B. B. 18	36	25	10·5	4	8
	100	70	29	11	22
S. B. B. 3	36·5	24	10	4·5	8
	100	65	27	12	23
	38	25·5	10	5	8
	100	67	26	13	21
	38·5	25 5	11	5	8·5
	100	66	28	13	22
	40·5	26	11	4·5	8
	100	64	27	11	20
	41	27·5	11·5	4·5.	8·5
	100	67	28	11	20
P. C. M. 2	42	27·5	11·5	6	7·5
	100	65	27	14	18

If these figures are examined it will be seen that the skulls of the *Nesokiæ* as compared with those of *Gunomys* are broader, have somewhat shorter nasals, very much shorter foramina, and longer molar series. They also show that on the whole the longest skulls have the smallest teeth; the longest skull of all—P. C. M. 2—also approaches the type of *Gunomys* in having relatively the longest palatine foramen. On the whole, however, there is no evidence that the longest skulls possess the longest palatine foramina.

There is little doubt that these twenty-four *Nesokiæ* represent two races, a larger and a smaller. The small race is perhaps confined to the immediate neighbourhood of the village of Atari.

Habits.—Before leaving the subject of the Punjab mole-rats, it must be mentioned that not a single individual was found in a dwelling-house or building of any description, although the measures against rats were so thorough that both *Mus mettada* and *Gerbillus indicus* were on rare occasions caught in dwelling-houses. This is most remarkable, for there is not the slightest doubt that the mole-rat, *Gunomys*, is a common house rat in Calcutta, Rangoon, Dacca and Darjiling.

Pjb. 7, Mus mettada—

Thirty-seven of these field rats have been received from Captain Davys. Of these fifteen are considered to be adult, though there is some doubt as to the maturity of the smallest of them. The large proportion of young ones in the collection is due to the fact that when this rather uncommon rat has been met with, one or both parents together with their brood have been dug out from a burrow and the whole sent together to the Museum. Usually a mature female with her brood of two to four young have been received. These families are all from the neighbourhood of Amritsar, but were obtained at different times and in different parts of the district. Some of the broods show characteristic peculiarities of their own, equivalent to the family likeness among mankind; although the peculiarities which constitute a family likeness are trivial in degree, they are measurable, and are as large as those on which "species" of rats have been (I do not say, usually are) established.

Because of a recent attempt [6] to split up the Mettads of a small part of India into three species, it has been thought well to give the full measurements of all the adults which we have received.

The whole collection of adults has been arranged in a series as regards their length. As the number dealt with is small, it is impossible to say what the mean length is; it is probably about 145. If, instead of arranging them in series, they are placed in groups according to occasions on which they were received, they present the following: Group A 132; B 154, 140, 150, 130; C. 114, 128; [illegible] E 145, 134; F 142, 157; G 154; H 146.

Serial No.	Length.	Tail length.	Foot.	Ear.	Greatest length.	Greatest breadth.	Skull. Nas.	Skull. P. F.	Skull. M. S.	Remarks.
1	114	..	20	12	28	15·5	11	7	5·5	3rd molar cut and worn. Generative organs not quite mature.
2	117	99 (84%)	24	13	29	..	11·5	7	5·5	
3	128	96 (75%)	21	11	30	16·25	12·5	7·5	6	3rd molar much worn down. Adult.
4	130	92 (70%)	22	17	30	16·75	12·75	7·75	6	,,
5	132	100 (75%)	23	10	31	15·5	12	7·75	5·75	,,
6	134	103 (76%)	21	11	30	16·5	13	8	6·25	,,
7	138	102 (73%)	23	12	30	16	12·25	7·75	5·5	,,
8	140	115 (81%)	23	12	33	16·75	13·25	8	6	,,
9	142	115 (81%)	23	12	30	16		7·75	6	,,
10	145	120 (82%)	22	13	33·25	16·25	13 25	8·5	6·25	,,
11	146		23	14	32	17	13·5	7·5	5·5	,,
12	150	..	22	12	32·5	16·25	13·5	8·	6	,,
13	154	..	23	13	33	17	13	7·5	6·5	,,
14	154	105 (68%)	20	12	32·75	16·25	13·5	8	6	,,
15	157	130 (82%)	23	14	33	16·5		8·5	6	,,
		77%								

Each group was collected at a different time and from a separate colony. There is little indication of similarity in the members of particular groups. If we examine the proportions of the several litters of young ones, family likeness is apparent. We have received in all seven or eight of them, though some have become mixed.

The measurements quoted are of length and tail length.

Batch.	Length.	Tail.	Percentage.
E. D. L.	104	68	65
	105	73	69
D. I. G. (two or three broods mixed).	81	67	82
	82	63	77
	84	67	80
	92	74	79
	95	79	79
	78	63	80
	80	63	78
	81	58	71
S. M. P.	94	64	68
	91	66	72

Batch.	Length.	Tail.	Percentage.
F. E. M. (two or three broods mixed).	77	61	76
	83	76	91
	85	63	74
	85	65	76
	86	65	75
	89	73	82
	91	76	83

The four lots were received on separate occasions; the members of every brood must have been nearly of the same age except those of brood E. D. L. which are considerably older. The average tail percentage of the fifteen members contained in batches D. I. G. and F. E. M. together is 78·8. The broods E. D. L. and S. M. P. show values well below this average.

It might be thought that this was evidence of two separate races of *mettada* in the Punjab. However, an examination of the measurements of the fifteen adults does not confirm this idea. The peculiarities shown by the broods E. D. L. and S. M. P. are probably due to family likeness.

Colour.—All the specimens closely resemble one another in colour, the fur is about 15 mm. long and very soft, like prepared sealskin, the basal three-fourths of each hair is of a very dark slate-colour, the remainder being fawn-coloured, sometimes of reddish tint. Some hairs project beyond the majority and have black tips.

The tails are variable in colour, they are always lighter below than above, but whereas some are pure white below and scantily pigmented on the upper surface, others are lightly pigmented below and nearly black above.

Skull.—The principal measurements of the skull are shown above. The great length of the palatine foramen, and the antero-posterior curvature of the upper surface are the principal characteristics.

Habits.—It must be mentioned that Davys found these field rats in dwelling-houses on two separate occasions.

Captain Davys's operations extended beyond Amritsar into the Lahore, Jullundur and Lyallpur districts: in the foregoing description the collection has been treated as a whole.

The measurements of the Lyallpur rats are shown separately in the diagram, text-fig. 3. Unfortunately we have not as yet been able to deal with a large collection of *Gerbillus*, *Goalunda* and shrews which have also been received from Amritsar.

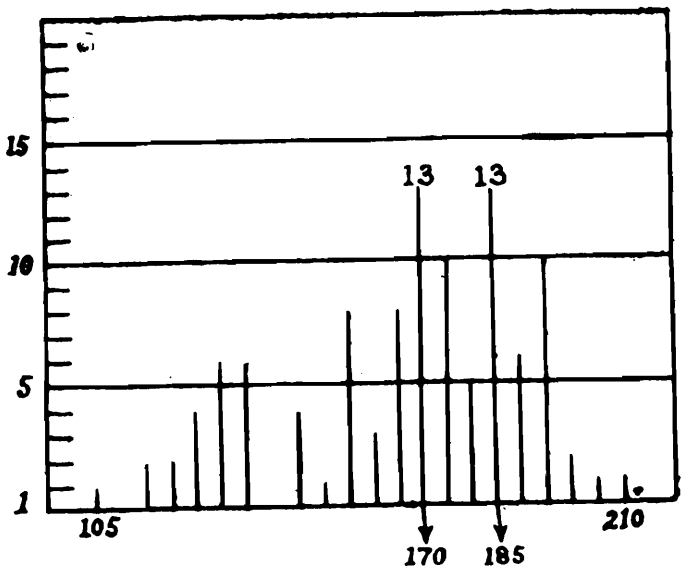

FIG. 3.—Diagram showing the length-frequency of 105 *Mus rattus* from Lyallpur (Davys).

Rawal Pindi.

Captain H. H. Broome has sent measurements and skins of fourteen *Mus rattus* from Rawal Pindi. They were selected from among a large number in order to show the extent of the colour variation. Two of them are white-bellied, the others are pigmented below but are variable above; in some the colour is light reddish brown, while in others the coloured element is much reduced and the general tone is much darker. The average length is approximately 180, but there is one specimen of 220 mm.

BALUCHISTAN.

Quetta.

Mr. W A. Cummings has sent us a well-preserved collection of over fifty field rats from the neighbourhood of Quetta. He has also informed us that, so far as he can ascertain, there are no house rats in Quetta. His excellent collection of field rats gives support to this statement, for, as a rule, house rats are caught with much greater ease than field rats. The relative number of the two kinds obtained from all parts of India shows this, but it must be remembered that Mr. Cummings, as the Honorary Curator of the Quetta Museum, has approached the subject as a naturalist, whereas most of our contributors have been Medical and Sanitary officers whose interest in house rats is special. For this reason I think that Mr. Cummings's statement requires confirmation. If it could be shown that the grain-sellers' shops of the Quetta bazaar are not infested with *Mus rattus*, and if the cause of their absence could be discovered, we should be in possession of important information.

More than half the collection is made up of *Gerbillus erythrura*, the well-known Afghan antelope rat, the feet of which have hairy

soles. Since this species has been excluded from a recent compilation of the genus *Gerbillus* (or *Tatera* [13]), it is probable that the name given in the *Fauna of British India* has not been accepted. The reason for this is not obvious, for the skull of the species is scarcely to be distinguished from those of the *Gerbilli* found throughout India.

Qta. 1—

The collection contains a number of *Nesokiæ* which, with one exception, very closely resemble one another in size, proportions and quality of fur. It has not been found easy to identify these with any particular species of *Nesokia*. They are a different race from the *Nesokiæ* found in the Amritsar district. They can best be described in comparison with these latter. The fur is longer, much more abundant, and of a lighter shade in the Quetta race.

Unfortunately measurements of the freshly killed specimens are not available, but it is likely that they are somewhat larger and have a slightly shorter tail than the Amritsar rats. One of them is shown in plate ii, fig. 1. The feet are certainly not larger than those of the other race. The skulls of the two races are indistinguishable, the large incisor teeth and the short palatine foramen being the peculiar feature in both. Judging from the stuffed specimens the average measurements of the race seem to be about 180, 95, 30, 18.

Qta. 2—

One specimen differs from the others in two respects: the fur contains numerous long bristles 45 mm. in length, and the tail is somewhat longer. The latter point is not of much importance, but the former constitutes a striking difference, for all the others are quite devoid of bristles. Because of these peculiarities, it was at first sight suspected of being a *Gunomys*, but examination of the skull shows that it is a typical *Nesokia*, that is to say, it has a short palatine foramen.

In regard to the question of the absence of *Mus rattus* from Quetta, the following passage may be quoted from the *Bombay N. H. S. Journal*, vol. xviii, No. 4, 1908, page 942: "Mr. Anderson enquired if anyone had seen in Quetta the Indian house rat (*Mus rattus*). The reply was in the negative." The question was put to the members of the Baluchistan Natural History Society at Quetta.

THE RATS OF THE HIMALAYAS.

These must be considered together, for they collectively present certain differences from the rats of the plains. Moreover, there are among them several distinct races which are easily recognisable from one another. This enquiry has shown that the

house rats of India, so far as they have been examined, cannot easily be separated into distinct races, although in some districts they are of purer breed or less variable than in others. The greater racial separation among hill rats appears to be a necessary effect of their environment, which, by causing isolation, must encourage pure or inbreeding and lead to the establishment of dominant races. Apart from racial distinctions hill rats as a whole show certain characters. Their fur is long, fine and plentiful, and combines to form a warmer coat than that of the lowland rat. Moreover the tail of the hill rat is comparatively short. This is equally true of the rats of Kashmir, Naini Tal, Darjiling and Katmandu. *Mus jerdoni* is a rat which has an unusually long tail and spiny fur and seems an exception to the rule, but it is not the common rat of Darjiling at the present day; it is probably an inhabitant of the low slopes of the Eastern Himalayas.

The differences between the highland and lowland rats seem to be of the same nature as the differences between the races of mankind which are similarly situated. It is certain that racial distinctions are more frequent and more clearly defined among hillsmen than among plainsmen; it is hardly less certain that men of the various hill tribes of the Himalayas show collectively certain peculiarities. They are generally of shorter stature and stouter limb than the men of the plains.

Himalayan rats have been received from Srinagar, Simla, Naini Tal, Darjiling and Nepal. They present some interesting biological problems, the solution of which will require a wider investigation than has been carried out at present.

Kashmir.

We have received from Dr. Mitra of Srinagar the skins of ten rats caught in that district. One of these is a mole-rat of the genus *Gunomys*. The others belong to the *Mus rattus* group.

Ksh. 1—

Includes eight rats which were taken from a well-marked race. Although measurements of the freshly killed rats were not recorded, there is no doubt that the tails of all of them must have been shorter than is usual among the members of the *Mus rattus* group. When the dried tails are turned forwards and laid along the back, their tips do not reach the level of the ears. When the dried skins of lowland rats are examined in this way, they commonly reach the tip of the snout or beyond. There is little doubt that the tails of these Kashmiri rats were hardly as long as the combined length of the head and body.

In all the under-parts are pure white. The dorsal fur, though somewhat variable in colour, is dull reddish grey. The component hairs are long, slender and very plentiful, and form a warmer coat than is found on lowland rats. Spines are

inconspicuous. Some of them have well-developed bristles which are in one case as much as 5 cm. in length.

The characteristic feature of the race is the bicoloration of the tail. In all the lower surface of the tail is devoid of pigment, and is sharply marked off from the pigmented upper surface. The ears are covered with fine hairs which are longer and more plentiful than those found in lowland rats. This peculiarity is doubtless concomitant with the general plenitude of the fur. It causes the margins of the ears to appear as though fringed with white hairs. Microscopical examination, however, shows that the hairs of the margin do not differ, in the distribution and amount of their contained pigment, from the hairs which cover the whole outer surface of the ear. It was found that all the hairs on the ear are pigmented only in the stouter basal half;—the finer terminal half appears like clear glass beneath the microscope. The actual margin of the ear supports few or no hairs. The appearance of the white fringe received by the naked eye, is due to those hairs which, arising close to the margin, project beyond it. It will be seen that this detail is of importance. This race has been regarded as *Mus vicerex*. On page 358, vol. xvi of the *Bombay N. H. S. Journal*, Colonel A. E. Ward states: "We have practically settled that *Mus vicerex* is the common rat of Kashmir." From the context it appears that this determination was made at the British Museum, where the type of *Mus vicerex* from Simla reposes. The eight specimens forwarded by Dr. Mitra all agree in being reddish grey above and pure white below, in possessing short bicoloured tails and apparently white-fringed ears. These are the essential characters of *Mus vicerex*. It is, however, by no means certain that the Kashmiri race is in direct genetic relation with that rat found at Simla which is the type of *Mus vicerex*, for most of the races of Himalayan rats have short tails, and the white-fringed ear seems merely a concomitant of the general abundance of the fur. The same character is well shown by our specimens of *Mus blanfordi* (Nilgiri Hills), which species also possesses sleek abundant fur, but is certainly not closely related to *Mus vicerex*. The question whether bicoloration of the tail can be independently acquired on many occasions will be discussed later on. This particular character was met with in a single rat in Rangoon which appeared to be a sport; and also, in an unstable condition, among a small community of rats in Naini Tal. If we deny the possibility of its manifold origin we should do the same for the character of albiventralism, regard the white-bellied rats of Tellicherri, Cawnpore, Calcutta and other places as of one stock, and suppose that they hold themselves aloof from the other rats of those places.

The skulls of these eight rats do not seem to differ from those of the lowland rats.

The tail of one of the Kashmir rats, though darker above, shows a certain amount of pigment in the skin and hairs of the lower surface.

Ksh. 2—

This heading is reserved for one rat which possesses a unicoloured dark tail. The appendage is incomplete, so its length is unknown. The fur is plentiful, but the component hairs are shorter and stiffer than in most of the eight rats included in group Ksh. 1.

Ksh. 3, *Gunomys wardi*—

One specimen was obtained. The dry skin measured 220 mm. in length, the tail 120. The fur is long, soft and plentiful; bristles are present but inconspicuous. The skull has a long palatine foramen measuring 10 mm., the molar series being 1 mm. less than this.

Simla.

We have received from Captain G. I. Davys fifty-eight specimens of the *Mus rattus* type, and three mole-rats of this place. It was somewhat surprising to find that none of the fifty-eight possessed bicoloured tails, for this is the characteristic feature of *Mus vicerex*, a species which was described in 1903 from eleven rats caught in Simla. This anomaly is explained by the supposition that the eleven rats from which the type of *Mus vicerex* was chosen were all caught within one limited area in the Simla district. This supposition will be vindicated in considering the rats of Naini Tal.

Of the fifty-eight specimens nearly all are of the white-bellied type. As regards size and length of tail they scarcely differ from the Punjab type of *Mus rattus*. The collection contains many juveniles, but among rats measuring over 150 mm. in length, those of 170 mm. are in the majority; but there are two specimens which measure over 200 mm.

The tail length is about 115 % of the length. This is short for *Mus rattus*, but not shorter than is found in some groups of the Punjab rats. The tails of all of them are black or blackish brown, and show the same depth of pigmentation on the upper and lower surfaces. The collection will be divided in the following manner:—

Sml. 1—

This group includes three rats which do not show white fur on any part of the body. They do not, however, closely resemble one another in colour. One of them is semi-melanotic; it is, however, a young rat, and such are generally darker in tone than adults.

Sml. 2—

This includes the remaining fifty-five, all of which show some white fur. They may be arbitrarily divided into the following sub-groups:—

Type A.—Contains seven specimens of the pure white-bellied type in which every hair on the belly, breast and throat is pure white.

Type B.—Contains twenty-three specimens which resemble type A but possess a coloured line about one inch in length in the middle line of the breast between the fore legs.

Type C.—Includes twenty-six specimens which show areas of white fur on the ventral surface but which are not of types A or B. Some of these show a dark stripe in the mid-ventral line along the whole length of the under side. In others this line spreads outwards in a diffuse manner to meet the coloured sides, so that there are four isolated areas of white fur on the inner side of each of the limbs.

Sml. 3, *Gunomys sp.*—

There are three examples of this species which resemble one another very closely. They are of large size and are covered with coarse bristly fur, the bristles being stout and 6 cms. in length. The measurements are—

237	187	44	15
235	br.	45	15
247	br.	41	18

In colour they closely resemble the Punjab *Gunomys*, but they are somewhat larger than the largest of these. Their skulls measure—

Length.	Breadth.	Nasals.	Pal. for.	Molars.
47·5 100	27·5 58	14·5 30	10	9
48·5 100	29 59	14·5 30	10	9
45·5 100	27 59	13·5 30	9·5	9

Naini Tal.

The rats in the neighbourhood of Naini Tal were recently examined by the writer. Since plague preventative measures were not in force it was not possible to examine them in great numbers. Observations were made in five separate places. In the outhouses of the Naini Tal Brewery (alt. 5,000 feet)—five specimens. Bhowali Bazaar, a place situated about ten miles to the east of Naini Tal (alt. about 5,000 feet)—two specimens. Naini Tal Bazaar at the southern end of the lake (alt. 6,400 feet)—nine specimens. A European store at the northern end of the lake (alt. 6,400 feet)—four specimens. Two adjacent houses on Ayapata Hill with intervening outhouses (alt. 6,900 feet)—eight specimens. These

last are quite different from the others as regards coloration of the tail. Only those which were quite complete and freshly killed were measured. Several of them are immature.

	Length.	Tail length.	Foot length.	Ear length.	
Ntl. 1—					
Brewery	170	215 (126)	34	22	
	174	202 (116)	29	24	
Bhowali	205	200 (95)	32	22	
Naini Bazaar	170	200	30	24	Caught together—probably one litter.
	150	152 (101)	30	22	
	144	154 (107)	30	22	
	142	148 (104)	29	23	
Naini Store..	127	128 (100)	26	19	All immature—probably one litter.
	123	132 (107)	27	18	
	123	142 (115)	27	19	
Ntl. 2—					
Naini Ayapata House	125	138 (110)	30	22	
	105	107 (101)	27	18	
	147	162 (110)	29	22	
	150	169 (112)	29	22	
	162	180 (111)	32	23	
	185	197 (106)	32	26	

The measurements show that the tails of these rats are relatively shorter than those of lowland rats It is obvious that the rats of the Ayapata group do not differ in this respect from the rats taken at the level of the lake.

As regards colour the whole collection may be described together, for in this respect the members of it collectively resemble one another and differ from most lowland rats. The brownish element in the fur is present, but in abeyance, so that the general tone is dark grey. All of them appear white below, but two of them have coloured breast stripes, and in some of the Ayapata group every hair of the ventral surface is pale grey at the base; but at least three of this group have pure white ventral fur. A few of them have scanty fur with bristles and spines, and scarcely

differ from lowland rats in this respect, but in most of them the fur is plentiful, long and soft, and devoid of spines and bristles. Those with long soft hair usually have white-fringed ears. No type of fur is peculiar to any one local group. The individual with the longest and softest fur belongs to the Ayapata group, but the same group contains a specimen with somewhat bristly scanty fur. An old rat from the Brewery is conspicuous for the length and softness of its fur, which is devoid of bristles.

It must be strongly emphasized that the average quality and colour of the fur in the Ayapata group is not different from that of the rats found at the level of the lake. All are variable, but specimens can be readily selected from the Ayapata group and from the lake group which exactly resemble one another, except in the coloration of the tail. The truth of this cannot be too strongly expressed.

Ntl. 2, the Ayapata group—

The circumstances of the Ayapata group will be related in some detail as they are of great biological interest. Traps were set in a certain house on Ayapata Hill. The first capture was of two young rats caught together on the same night and in the same cupboard. These were so equal in their immaturity, that they were considered to be of the same litter. At first sight they did not seem to differ from the young rats of the bazaar. They were coated with soft dark grey fur, and their tails were relatively short. The tail of one of them was perfectly bicoloured, the lower half of its circumference was devoid of pigment and bore white hairs, the upper half was deeply pigmented and bore black hairs. The line of demarcation was sudden. The second specimen resembled the first except that the pigmented area of the upper surface did not reach to the tip of the tail, so that rather more than a third of the terminal portion of the tail was white in its whole circumference.

These two specimens caused great perplexity. By every systematic rule they should be of different species, each, again, being different from that found in the bazaar. The specimen with the completely bicoloured tail should be either *Mus vicerex* or *Mus niveiventer*, both of which species occur in the Himalayas and have short bicoloured tails; it is especially like the latter, which has greyish fur. The other specimen, in its partially bicoloured tail, resembles *Mus berdmorei* [4], a species which has been found in Manipur and Tenasserim, but not in the countries between. The circumstances, however, plainly indicate that these two rats are of the same race and that they are more nearly related to the rats of Naini Bazaar than to *Mus niveiventer*, which was discovered fifty rat-generations ago in Katmandu but has not been rediscovered.

Traps were set in a neighbouring house and in the intervening outhouses, with the result that six more rats were caught; the tails of all of them were pure white below, the pigmentation of the upper surface extending along the tail to a variable distance

from the root. In only one specimen does the dorsal pigmentation reach to the tip of the tail; plate iv, fig. 4, shows the tail of this rat as viewed from the side. In four specimens the pigmentation reaches only a short distance, so that most of the upper surface as well as the lower surface is pure white (fig. 1). In three others it reaches up to or beyond the middle of the tail but does not reach the tip; the tail of one of these latter, which was preserved in alcohol, is shown in plate i, fig. 2*b*. It was not possible to photograph the others for they were preserved as stuffed skins, in which state the lower surface of the tail is yellowish grey like old parchment, and that sharp contrast which is so necessary for photographic reproduction is lost. The figures on plate iv were drawn from the stuffed specimens. The contrast between the pigmented upper surface and the lower surface is much better shown in plate i, which is a reproduction of a photograph.

The partial albinism of the tail of each of these rats shows clearly that they must be of intimate relationship; they are in fact a large family group or a small race, but one cannot tell, from the eight specimens, what the type of that race is.

The single specimen with the wholly bicoloured tail resembles, as regards its tail, many known species,—*Mus vicerex*, *niveiventer*, *jerdoni*, *bukit*, *rapit*, all these being highland rats. This single specimen, however, cannot be considered as the "type" of the group. At least two of them, one of which is illustrated in plate i, resemble *Mus berdmorei* of Tenasserim and Manipur.

The skulls of these rats are of the *Mus rattus* type. The biological interest of the group is further discussed on page 89.

Darjiling.

A small collection was recently made in this district by Mr. Hodgart. This includes five of the *Mus rattus* group and eleven mole-rats. The five specimens of *Mus rattus* are from three separate places—Darjiling, Ghoom and Sonada. They will be considered together with five rats which were caught by Dr. Hossack in Darjiling.

Djl. 1—

The ten rats resemble one another so closely that they must be members of one pure-bred race; their skulls are of the *Mus rattus* type; they are covered with abundant long soft fur, in which the brown element is so poorly developed that the tone of the dorsal surface is almost black. Each hair on the ventral surface is of a dark slate-colour, with a fawn-coloured tip. The tails are much shorter than those of lowland rats. In every specimen, the upper surfaces of the feet are covered with white hair, the soles being deeply pigmented. This race is as distinct as the Kashmir race, Ksh. 1, which it resembles only in the softness of the fur and the shortness of the tail. Dr. Hossack, who considered the race to be *Mus nitidus*, observed that the tails of these Darjiling rats were somewhat lighter below than above. The tails of rats from many

other places show this peculiarity, especially if they are thoroughly washed in alcohol. The Darjiling race is quite different from the Kashmiri and Naini races, in which not only the lower surface of the body but also that of the tail is pure white. The measurements of the ten specimens are as follows :—

	Length.	Tail length.	Hind foot.	Ear.
Darjiling Telegraph Office	183	181	36	21
	180	166	36	24
Ghoom Bazaar	198	207	36	22
Sonada	147	131	32	20
	178	162	37	22
Darjiling rats (Hossack)	180		37	21
	130	135	33	20
	130	140	32	20
	195	185	36	22
	185	185	35	22

The measurements are of freshly killed rats with unbroken tails. Three of these rats are immature. The measurements show that the average length of the race is about 180 mm. and that the length of the tail is somewhat less than that of the head and body.

Djl. 2—

Eleven typical specimens of *Gunomys bengalensis* were caught in the houses of the bazaar at Darjiling, Ghoom and Sonada. They are thickly furred and bristly, but differ from the Simla group 3 in size. An average specimen measures 197, 142, 33, 21. They seem to be common house rats in Darjiling ; they were caught during the rainy season.

Nepal.

Thanks are due to Lt.-Col. J Manners-Smith who, despite more than one unsuccessful attempt, eventually succeeded in sending two consignments of live rats to the Indian Museum, as well as a number of specimens in alcohol.

We have received in all nine house rats, eight mole-rats and a bandicoot.

Npl. 1, *the rattus group*—

The rats of this group which we have received from Katmandu belong to a distinct race, distinguished by the large size of its

members and the abundance of their fur. Our conclusions are based on the examination of four rats which were received alive, and confirmed by an examination of five specimens received in alcohol. The measurements are—

205	220	37	28
234	225	37	27
210	210	39	26
206	227	38	27

Considering these measurements and judging also from the five spirit specimens, we may conclude that the average length of the members of the race is about 210 mm., and the average tail length some 5—10 mm. more than this. The hind feet are relatively short. The fur is remarkable for its length and density, spines are absent in some, present but inconspicuous in others. Slender bristles 4—5 cm. in length are present in all.

The general colour of the fur is not unlike that of *Mus decumanus*; the brown element is well represented, the terminal quarter of each hair being yellowish brown. In this respect they differ from the darker rats of the Darjiling race (Djl. 1).

The hairs of the ventral surface are long and plentiful, with grey bases and reddish fawn-coloured tips. The whole circumference of the tail is deeply pigmented. The ears, unlike those of most thickly furred rats, are covered with very short inconspicuous hairs; except for their size, the skulls show no constant peculiarity.

Npl. 2, *Gunomys tarayensis* (?)—

There are eight specimens from Butal, a place situated in the plains on the Nepalese frontier. They were taken from burrows in the fields.

They closely resemble one another and are remarkable for the length and density of their fur; an average specimen measures 196, 140, 31, 21. Their skulls resemble the *Gunomys* of Calcutta.

Npl. 3, *Bandicota nemorivaga*—

One specimen from Katmandu must be referred to this species; it is not more thickly furred than the members of the same species found in Calcutta, and it appears to be indistinguishable from these in every way; it was found burrowing in the gardens of the Residency. It measures 260, 225, 50, 30. The length of the nasal bones is 34 % of the total length of the skull.

THE UNITED PROVINCES.

Allahabad.

We have received the measurements and skins of 182 rats from Lieut. Palmer. This useful collection consists entirely of *Mus rattus*. The frequency with which rats of different lengths occur, is displayed by the upright lines in the diagram, text-fig. 4. This shows

that the rats of 165 mm. in length are in the majority, but that rats of 200 and 205 mm. are to be found. This diagram agrees with that which displays the length-frequency of the Punjab rats, text-fig. 1. The difference of 10 mm. between the maxima in the two cases is accounted for by the fact that in the Punjab the measurements were taken from the first ring of the tail to the snout, while at Allahabad they were taken from the anus to the snout. The distance between the anus and the first ring of the tail in an average sized rat is about 10 mm. It must be emphasized that these measurements were recorded by two different persons, both un-

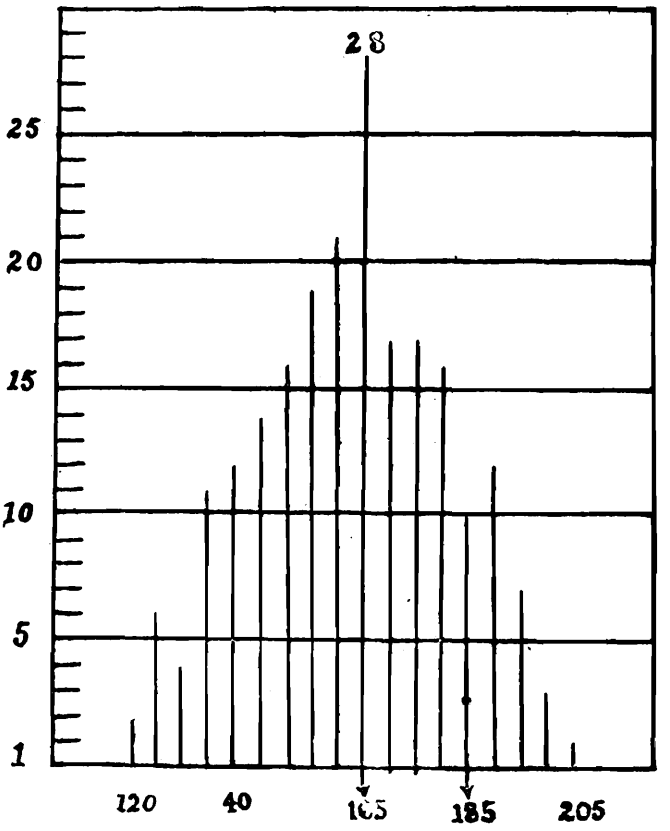

FIG. 4.—Diagram showing the length-frequency of 182 *Mus rattus* from Allahabad (Palmer).

acquainted with the purpose to which their records were to be put, and that, without excluding immature specimens, all the measurements have simply been sorted into groups and represented in the diagrams. They show conclusively that a rat of 145 mm. and one of 205 mm. may be of the same race. It has been already shown, in mentioning some of the latest additions to Indian mammalian fauna, how little this fact is realised.

In the proportions of the tail, feet and ears, the Allahabad rats do not seem to differ from the rats of Calcutta, as described by Hossack. According to the colour of their fur they may be divided into three groups.

Alh. 1—

Includes 169 rats of the yellowish brown dark-bellied type. They are variable in the colour and character of the fur, and

especially as regards the bristles and spines. They are included in one group because they show no white fur on the abdomen although some are lighter below than others.

Alh. 2—

Includes twelve rats differing from the others in being white below. These do not show the coloured stripe in the mid-line of the breast which is often present in white-bellied rats. In one of them although the ventral fur appears pure white, each of the component hairs is light grey at the base; in the others every hair is white in its whole length.

Alh. 3—

Includes one albino specimen; it is of a pale straw-colour rather than pure white. The ears, nose and feet are devoid of pigment.

Cawnpore.

Captain H. Fulton has sent the measurements and stuffed skins of thirty-one specimens of *Mus rattus*. The lengths of these are displayed in the diagram, text-fig. 5, which shows that rats of about

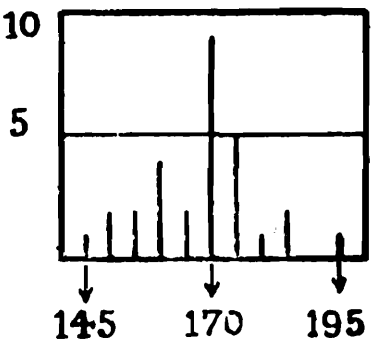

FIG. 5.—Diagram showing the length-frequency of 29 *Mus rattus* from Cawnpore (Fulton).

170 mm. are clearly in the majority. This collection has been made with particular care, and does not include any specimens of doubtful maturity. The diagrammatic representation of these measurements is therefore of special interest. In regard to proportions there seems little difference between the rats of Cawnpore and of Calcutta. The average tail-length among the group is a little over 120 % of the length of the head and body. The collection falls naturally into three groups according to colour.

Cnp. 1—

The eye can distinguish two of them from the others at a distance of fifty yards owing to their black colour. On close inspection it is seen that they do not entirely resemble one another. In one specimen, a male measuring 145, 188 (br.), 31, 32, the back is covered with hairs most of which are dark slate-grey in the lower two-thirds of their length, and black in the upper third. Intermingled

with these are numerous flat, pointed spines of a light grey colour, with black tips. Besides these there are many slender bristles, about 3 cm. in length and black in colour, showing a dark green iridescent lustre. The green lustre can be seen on a single extracted hair if light comes to it at a particular angle ; it is often to be seen on the bristles of *Mus rattus*, especially when they are wet. There is no sign of a yellow or brown tint in any of the hairs. The ventral fur is dark slate-grey. The second specimen, a female measuring 144, 201, 33, 24, is at a yard's distance almost indistinguishable from the other ; close examination, however, shows that it differs in the following respects. The light grey spines are much less numerous, and less conspicuous among the fur. The bristles are not more than 2 cm. in length and do not show iridescence. There is a brownish element in the general colour. The fur of the flanks and shoulders especially shows a distinct trace of yellowish brown.

It is remarkable that these two black rats, although obviously mature, are the two smallest specimens in the whole collection. There is some evidence to show that the black *Mus rattus* is usually smaller than the brown. Hossack, in speaking of the few black rats obtained in Calcutta, says, " except that none of the eight exceed 16·5 cm. in length, there is nothing in either the body or cranial measurements to distinguish them from normally coloured rats." We have received four black and three brown specimens of *Mus rattus* from Freemantle, Australia. The former are all smaller than the latter.

It has been shown in describing the rats of Rangoon that blackness is not associated with smallness in the allied genus *Gunomys*.

The skulls of these two black rats from Cawnpore are somewhat unlike one another ; although there is only half a millimetre's difference between their total lengths, there is a difference of 2 mm. between the lengths of their nasal bones.

Cnp. 2—

Includes seven specimens in which the fur covering the lower surface of the throat, breast and belly is white. In two of these the ventral fur is long and pure white, perhaps with a faint tinge of lemon-yellow, but there is no coloured stripe in the middle line of the breast. In the other five there is some colour in this situation ; in one the hairs in the mid-pectoral line are pale grey, in another pale grey tipped with fawn, in a third the coloured line is very distinct and joins a transverse line which crosses the breast between the fore legs.

Cnp. 3—

This includes the remaining nineteen, all of which are dark-bellied, each ventral hair being, as usual, dark grey, tipped with yellowish or reddish brown.

In order to be able to express the amount of difference in appearance between the members of these groups, the writer ascertained by trial the longest distance at which a person of normal vision could distinguish the three kinds from one another. It was found that in a good light the three could be easily named at a distance of thirty yards, and less easily even up to fifty yards.

On the one hand, we have seen in discussing *Mus listoni* and *M. comberi*, that at the present day species are founded on such small differences that the fact of their being at all appreciable by the naked eye is considered noteworthy, while on the other hand we now see that differences which are appreciable at a distance of 50 yards are not considered of specific value. This is the natural outcome of the conviction that organisms of any particular species—elementary or indivisible—can only give birth to offspring of the same species. This conviction is of course based on the common experience that like as a rule gives birth to like. The belief that there are no exceptions to this rule is so strong that evidence afforded by the eye cannot be believed, and certain species have been considered indivisible but polymorphic. *Mus rattus* is one of these. All who have written about Oriental rats are agreed that the common brown *Mus rattus* (*alexandrinus* or *rufescens*) usually has a brown belly, but that there is a second form with a white belly, and some have justly considered that the black rat is merely a third form. But all have regarded the two or the three forms as one indivisible species. It has been felt that to regard them otherwise would be to admit the discontinuous and manifold origin of species.

Although it is difficult to gauge the general opinion of biologists from the writings of individuals, it seems that this admission, so distasteful to many, is gaining in favour at the present day; the evidence afforded by the rats of India seems to be in favour of it.

Hardwar.

Mr. Pitambar Paul has sent a useful collection of fifty *Mus rattus* in alcohol, with measurements of each.

The lengths of these range from 140 to 200 mm. A large number of immature individuals have been included, but there are more rats of 180 mm. than of any other length. If their lengths are arranged according to their frequency they show the same kind of diagram as text-fig. 2, in which the measurements of a large number of immature rats were included.

As regards colour they are all of the brown dark-bellied type found commonly throughout Northern India; two of them are white-bellied with a broad coloured stripe in the middle line of the breast and abdomen.

Ballia.

The Civil Surgeon of Ballia has sent a typical dark-bellied *Mus rattus*.

Gonda.

We have received eighteen rats in alcohol from the Civil Surgeon of Gonda. Sixteen of these are of the brown, dark-bellied type of *Mus rattus*, and show no peculiarities; two are typical examples of *Gunomys bengalensis*, probably from the fields.

Ghazipur.

Mr. R. S. Misra has sent the measurements, skins and skulls of seven rats. All are brown specimens of *Mus rattus*; two of them have white bellies, the others being of the common dark-bellied type.

Azamgarh.

The Civil Surgeon of this place has sent four brown, dark-bellied *Mus rattus*.

Saharanpur.

Mr. K. V Amin has sent two house rats and a shrew. The rats are large examples of the common brown, dark-bellied type of *Mus rattus*. Their lengths are 193 and 200 mm.

Moradabad.

Lt.-Col. M. Cadell has sent four specimens of *Mus rattus*; they are of the brown, dark-bellied type. Their lengths are 162, 181, 185, 190. Their proportions are normal.

Bulandshahr.

Captain K. J Walton has sent five brown, dark-bellied *Mus rattus* of ordinary size and proportions.

Lucknow, Rai Bareili, Dehra Dun, Agra.

Mr. P. Stebbing has sent four rats from Dehra Dun, Mr. R. A. Hodgart has obtained ten from Lucknow and one from Agra, and there are four from Rai Bareili sent by an unknown correspondent. These nineteen rats closely resemble one another; they are all of the common yellowish brown, dark-bellied type of *Mus rattus* obtained from Allahabad, Cawnpore and many other places.

CENTRAL INDIA AND THE CENTRAL PROVINCES.

Nowgong.

Captain J Skinner has sent the large number of 115 rats with the measurements of each. Of these eighty-one are *Mus rattus*, one is *Mus mettada*, and the remainder are *Gerbillus indicus*. The lengths of the house rats are shown in the diagram, text-fig. 6; they vary from 150 to 210 mm., those of 180 and 185 being in the

majority. The rats of Nowgong therefore appear to be somewhat larger than those of other parts of India, but this may be due to some peculiarity in the recorder's method.

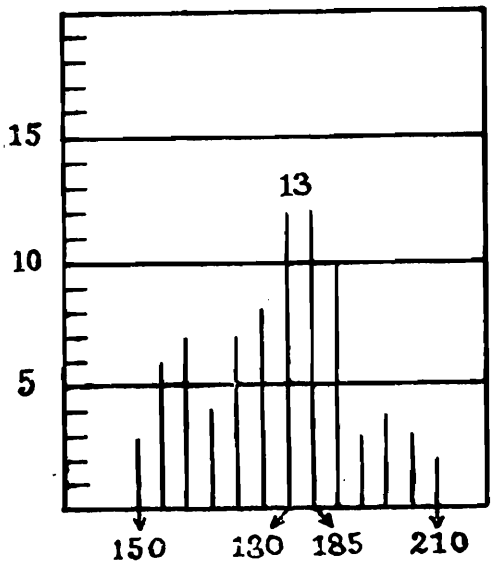

FIG. 6.—Diagram showing the length-frequency of 81 *Mus rattus* from Nowgong (Skinner).

In their proportions and in the colour of the fur they show no peculiarities; they are all of the yellowish brown, dark-bellied type. One of them shows a clear white streak in the middle of the breast like the rats shown in plate i.

The single specimen of *Mus mettada* does not seem to differ from the Punjab Mettad.

It has not been found possible to include *Gerbillus* in this report.

Buldana.

We have received fifty-three dried skins and skulls from Mr. Srinivaslu Naidu. This collection contains twenty-two *Mus rattus*, twenty-three *Gerbillus indicus*, four *Gunomys bengalensis* and four *Mus mettada.*

Bld. 1, *Mus rattus*—

These are of the yellowish brown, dark-bellied type; all are somewhat darker than usual, and resemble one another closely.

Bld. 2, *Mus mettada*—

There are four dried skins and skulls of these field rats. The skins have been stretched in drying so that they do not directly indicate the size of the rats from which they were taken. Two of them are about 180 mm. in length, the other two being about 150. Teats can be found on the smaller skins only, so that the difference in size, which in the live rats was probably only about 20 mm., is most probably sexual. It is, however, possible that

the smaller and the larger were taken from different colonies. In fur quality the four resemble one another very closely; they differ from the Punjab Mettads in having shorter and darker fur. In the latter the length of the dorsal hairs is about 15 mm., the colour dark slate-grey with about 3 mm. of the terminal portion of a reddish fawn. In the Buldana Mettad the fur is about 10 mm. in length, the coloured terminal portion being about 2 mm. in length. In both the fur is as soft and silky as mole-skin. No constant differences can be found between the skulls of the two races.

The lengths of the palatine foramen and the upper molar series in each of the specimens is as follows: 9 and 6, 8·5 and 6·5, 8 and 6, 8·5 and 6. The large excess in the length of the palatine foramen is well known to be the characteristic feature of the skull of this species.

Bld. 3, *Gunomys bengalensis*—

The four skins have evidently been taken from large rats, one skin measuring as much as 270 mm. from snout to root of the tail; the rat from which it was taken probably measured as much as 240 mm. Two of the others must have been about 200 mm. in length, and the fourth about 175. There is a considerable difference in the character of the fur of the four specimens. They are all greyish brown, but the two medium-sized specimens have very light coloured bellies sharply contrasting with the darker sides, while in the largest specimen the belly is dark and this contrast is not seen.

It happens that the two light coloured specimens very closely resemble a skin of a *Gunomys* from Chingleput in Madras,—much more closely than they resemble the other specimens from Buldana.

In spite of the differences in colour the skulls of the four resemble one another very closely, all being considerably narrower than the average skull in a mixed race of *Gunomys* such as is met with in Calcutta. They resemble in this respect the skulls of the melanotic race of *Gunomys* found in Rangoon, but are somewhat narrower even than these. It is probable that increased size is correlated with diminution in the breadth of the skull, as in *Gunomys varius* and the genus *Bandicota*.

The measurements of these skulls are as follows :—

Length.	Breadth.	Nasals.	Molars.	Pal. for.
39·5	22·5 (57 %)	12·5	8·5	7·5
43·5	24·5 (56 %)	13	8·5	9
44	24·5 (55 %)	14	8·5	9·5
46	25·5 (55 %)	14·5	9·5	9·5

The breadth percentage of the skull in twenty specimens of *Gunomys bengalensis* taken from different parts of Calcutta varies from 58·4 to 63·3, the average being 59·8 (Hossack). It has also been shown that this percentage among *Gunomys* from the Punjab and other places is on the average about 60.

So far as we can judge from four specimens, the *Gunomys* of Buldana form a distinct race; it may be confined to a single set of burrows, for the same peculiarity, though to a lesser extent, was found among the rats of two adjacent houses in Rangoon.

Rewa, Burwani and Dhar.

From these neighbouring States in the west of Central India we have received twenty-one specimens of *Mus rattus*. All are of the brown-bellied type. Measurements of each have been received, and show that in proportions and size the common rats of these districts are normal. Mr. Ahia Ali Khan of Rewa has sent ten, Mr. P. L. Bhattacharya of Burwani has also sent ten, and the State Surgeon of Dhar has sent one.

Neemuch.

Captain A. Meaden has sent four similar rats from this place.

Sambalpur.

Captain J C. Gillmore has sent two specimens of *Mus rattus*; the lengths of these are 162 and 193 mm. There is nothing remarkable about their proportions. The dorsal fur is of a reddish brown colour. They are both of the pure white-bellied type, every hair on the throat, breast and abdomen being pure white from root to tip, and the white ventral surface is sharply marked off from the coloured sides.

BENGAL.

Calcutta.

Dr. Hossack has dealt with the rats of Calcutta so fully that little need be said in regard to them. Though admitting that the material on which his conclusions were based was somewhat limited, he was inclined to the opinion that the bandicoots of Calcutta and Madras were of the same species. We have since obtained a number of bandicoots from both Calcutta and Madras, so that this question may be re-opened. The meanings of the word "species" are such that it is difficult to decide the question whether these two groups should constitute different species or not; there is, however, no doubt that they are different races, and therefore, according to modern systematists, should be regarded as different species.

The measurements of the bandicoots of Madras city will be given presently. The measurements of six specimens from Calcutta

are given here for comparison. It may be mentioned that both sets of measurements were taken by the same hand.

	Length.	Tail.	Hind foot.	Ear.
A	235	215	50	28
B	260	244	49	29
C	260	239	52	32
D	277	251	51	24
E	278	235	53	30
F	295	br.	52	29

The skull measurements of these are as follows :—

	Length.	Breadth.	Nasals.	Pal. for.	Molars.
A	54	28·5 (53 %)	br.	10·5	10
B	55·5	28·5 (51 %)	19 (34)	11	11
C	..				
D	59	31 (53 %)	21 (35)	11	11
E	58	32 (55 %)	20·5 (35)	10	11
F	59·5	32 (53 %)	21 (35)	11	11

Comparing these figures with those given for the Madras bandicoot, we see that the latter are somewhat larger, have longer tails and longer nasal bones. The fur of the Madras rat is harsh, bristly and scanty. That of the Calcutta rat is also bristly but longer, softer and much more abundant. There is little doubt that individuals of both races could be found, which in one or more of the distinguishing characters would be intermediate between the two. The races, however, are none the less separate.

Purneah (Behar).

Mr. C. A. Paiva, of the Indian Museum, has made an interesting collection of field rats in this district; twenty-two of them are *Gunomys bengalensis*, three are *Bandicota nemorivaga.*

Those *Gunomys* which were measured in the fresh state have the following proportions :—

Length.	Tail.	Hind foot.	Ear.
165	125	26	22
165	132	30	20
175	138	31	25
175	120	31	22
175	139	30	22
175	162	31	22
180	166	31	22
180	126	32	22
185	139	26	22

The mean length of the members of this group is therefore considerably less than that of a mixed collection of the same species taken from Amritsar. These twenty-two rats may not, however, represent the mole-rats of the whole district of Purneah, for they were all taken from one colony or set of burrows.

In colour and quality of fur the members of this group are constant and are indistinguishable from the *Gunomys* of Calcutta, and like them they show differences from the *Gunomys* of the Punjab. In tail-length they are somewhat variable, but in the length of the hind feet they are more so. There are two adult specimens among them of approximately the same length. The one, a stoutly built male, has a hind foot measuring 35 mm. The foot of the other, a lightly built female, only measures 26 mm. The difference in appearance is striking. The females, however, do not constantly possess small feet.

The skulls vary in the same way and to the same extent as those of the Calcutta *Gunomys*.

The three bandicoots cannot be distinguished from *Bandicota nemorivaga* of Calcutta. Their measurements are—

A	238	200	46	24
B	250	231	52	22
C	275	250	51	28

A and B are females; neither seems quite mature. C is an old male. The last centimetre of its tail is pure white. This peculiarity has often been met with in other species. The skull of B is broken. The measurements of the others are as follows :—

	Length.	Breadth.	Nasals.	Pal. for.	Molars.
A	48·5	27 (55 %)	16 (33 %)	9·5	10
B	57	31 (55 %)	20 (35 %)	11·5	12

Puri (Orissa).

Dr. N. Annandale obtained two specimens of *Mus rattus* from the neighbourhood of Puri. Both are of the white-bellied type. In one of them, an immature specimen, the colour of the belly is pure white, in the other, an adult of normal size and proportions, the belly is light lemon-yellow ; it resembles very closely the rats from Travancore.

MADRAS.

Madras City.

The rats of Madras city were examined by the writer during February of this year, when about 700 were brought in daily from different parts of the city. The different species were separated and their numbers counted on two occasions. The results were as follows :—

	Mus rattus.	Bandicoots.	Mice.	Shrews.
1	392	92	220	28
2	275	82	143	15
TOTAL	667	174	363	43

Besides these, other species were occasionally obtained. In four days one specimen of *Mus mettada*, three of *Vandaleuria oleracea*, one *Gunomys* sp. and two *Gerbillus cuvieri* were brought to the collecting station ; these were most probably from the fields. Further counts were not made, as the numbers did not vary much from day to day.

These numbers cannot accurately represent the numerical proportions of the species actually present in the city. Probably the bandicoots are present in much larger numbers than they appear, for they must be more difficult to capture than the others. Examples of *Mus rattus* were frequently brought, two or three in one trap. The bandicoots were never trapped owing to their size. Almost all of these large rats were killed singly by blows from sticks. That this was the means by which they were obtained, was known not only from the assertions of the rat-catchers but also from the condition in which the dead bandicoots were obtained. Among large numbers examined it was difficult to find specimens the skulls of which were in an unbroken condition ; this difficulty was never felt in the case of other species. That it was possible to obtain nearly 100 bandicoots daily by such a method, shows that this formidable rat must be very plentiful in Madras.

Not a single specimen of *Mus decumanus* was obtained. It is difficult to assert that this rat, which is so common in other Indian ports, does not occur in Madras city. The evidence of its absence, however, seems almost conclusive.

Some hundreds of rats were being received daily during several months. From these one specimen of a greyish short-tailed rat was sent to the Madras Museum suspected of being *Mus decumanus*. This was examined by the writer, the skull being removed. It was obviously a *Gunomys*.

The rarity or absence of *Mus decumanus* can, however, be explained. The port of Madras differs from the other great ports of India. Long lines of wharves with steamers moored alongside are conspicuous features of the ports of Calcutta, Bombay and Rangoon. In the smaller port of Madras the conditions are different and steamers usually unload their cargoes at a jetty or by means of small boats. These conditions would deter the ships' rats from invading the shore in great numbers, but could not prevent the invasion altogether. A more potent factor in determining the suppression of *Mus decumanus* awaits those that reach the shore.

These large rats are well known as dwellers in the drains and outhouses of the ports of India, where they can sustain themselves in competition with other species. In Madras, however, they meet, to their detriment, with a larger and still more formidable race, the bandicoots, whose mode of life is remarkably like their own. A similar explanation may be given of the comparative scarcity of *Mus decumanus* in Rangoon, for in that city the large mole-rat, *Gunomys varius*, which was spoken of as "bandicoot" by the rat-catchers, is the common out-door rat. This race would compete successfully with *Mus decumanus* in the same manner though not with such complete success as the Madras bandicoot, for in the struggle the two races would be on more equal terms. In Calcutta and Bombay, *Mus decumanus* thrives with little competition. The bandicoots of Calcutta are rare and live in burrows after the manner of field rats, especially around the numerous tanks of that city. That competition and enmity between the different races of rats actually exists will be shown later (Appendix III).

Mds. 1, *Mus rattus*—

The rats of this group were examined somewhat superficially, few measurements being recorded. On inspecting a large number of them the general impression was received that they were somewhat smaller than the rats of other parts of India. The few measurements that were made confirmed this impression. It is not unlikely that the mean length of the race in Madras city is as low as 160 mm. or 1 cm. less than that of the race found on the west coast of Madras.

They were on the whole less variable than the western race. Melanotic and white-bellied varieties were not met with.

Mds. 2—

An interesting variety was found showing a pure white streak in the middle line of the breast. Two specimens showing this peculiarity were obtained. One of them in which the white line is of considerable length is shown in plate i, side by side with a rat showing the same character which was caught in Bombay. The same peculiarity has been noticed in Calcutta.

Mds. 3, *the large bandicoot*—

This species was long known as *Nesokia bandicota*. Since however, the new genus *Bandicota* has been established, it should presumably be known as *Bandicota indica* [11].

Proportions.—The first five adults met with were measured. The results were as follows :—

270	285	54	30
273	275	55	28
290	311	58	30
300	302	58	28
310	310	56	31

It is surprising to find that the tail-length is equal to or even slightly greater than the length, for these rats have previously been described as possessing tails less in length than the head and body.

Fur.—Almost every specimen was scarred and mangy, the fur being always sparse and very bristly. It consists of a soft under fur which is scanty and of a dull grey colour, from among which spring numerous spines, grey in colour with cream-coloured ends. These spines measure 2 or 3 cms. in length ; the longest ones are tipped with black. The fur of the back also contains long bristles, 6 or 7 cms. long, which are black in most of their length. It is an interesting fact that the fur of these rats is much more like the fur of *Gunomys varius* of Rangoon, than that of *Bandicota nemorivaga* of Bengal, the fur of which is comparatively soft and very thick. This can be explained by the fact that the Madras and Rangoon "bandicoots" are both drain-haunting town rats, whereas the Bengal bandicoot is a burrowing field rat. It is difficult to distinguish a piece of the excised skin of the Madras and Rangoon forms from one another, whereas both could be readily distinguished from that of a Bengal bandicoot. There is not, however, the slightest doubt that *B. indica* and *B. nemorivaga* are much more closely allied to one another than either of them is to *Gunomys varius*. A similar observation was made in the Punjab, where the thick fur of the *Gunomys* and *Nesokia*, which burrow in the same fields, is often of precisely the same quality, but quite different from the sparse fur of the *Gunomys* of Bengal.

Skull proportions.—The measurements of five skulls are as follows :—

Length.	Breadth.	Nasals.	Pal. for.	Molars.
63	34	26	12	10
100	53·9	41·2		
60	32	23·5	11	10
100	53·3	39·4		
56	Br.	23	11	11
100		41·0		
59	Br.	25	11	10
100		42·3		
56	Br.	22	10·5	10·5
100		39·3		

The Madras bandicoot differs from *B. nemorivaga* in being somewhat larger, in possessing sparse fur and a longer tail. In the skull the nasal bones of *B. nemorivaga* are about 35 % of the total length. In the skull of the Madras bandicoot this percentage is about 40.

Habits.—It was not possible during a short visit to become personally acquainted with the habits of these rats. Some interesting information was obtained from others. It has been already pointed out that the bandicoots must be very common in Madras city. Dr. J R. Henderson informed me that in certain streets of Madras, in which the drainage system was partly of an open nature, bandicoots could often be seen running about the roads during the still hours of the night. Dr. K. T. Matthews, Health Officer of the Municipality, also showed me some interesting facts regarding the habits of these rats. Most of the houses in Madras city contain a central courtyard which is tiled and open to the sky. Waste water from this yard leaves by a closed drain which pierces the front foundations of the house to enter the main drain of the street. At night the bandicoots enter the houses by means of these drains; to prevent this the openings of the drains into the courtyard are usually covered with iron gratings. Being checked by this device, the bandicoots make burrows beneath the tiled floors of the courtyards; these are so large that they not infrequently fall in. These collapsed burrows were seen in several of the houses.

These few facts illustrate the extent to which the bandicoots have established themselves among the drains of the city.

Mds. 4, *albino bandicoots*—

The Madras Museum received from the Municipal rat collecting station two very large white rats which appeared to be albino specimens of *B. indica.*

Mds. 5, *Gunomys sp.*—

Only one small female specimen of the genus *Gunomys* was obtained. The excessively worn condition of the 3rd molar tooth shows that it is an old rat. It measures 142, 108, 27, 18 : as compared with an average specimen of *G. bengalensis* it is very small and possesses relatively large feet. It has three pairs of pectoral and three pairs of inguinal teats which do not form a continuous series. In the proportions of the skull it does not differ from many specimens of *G. bengalensis*. The measurements are as follows : l. 38, b. 24, n. 11·5, p.f. 8, mls. 7.

It has been mentioned that another specimen of *Gunomys* was examined by the writer in the Madras Museum ; the measurements were not recorded ; it was, however, a very much larger rat than the one just described.

Mds. 6, *the Madras Mettad*—

A small adult rat was obtained which from its general appearance was recognised to be a Mettad. It shows at least one important difference from all other *Mus mettada* which have been obtained from other districts. The length of the tail is greater than that of the head and body. The measurements are 105, 112, 22, 17. The lower surface of the tail, though much lighter than the upper surface, is not devoid of pigment. The hair on the tail is shorter than in other Mettads. There is also a trace of a sixth foot-pad on a level with the fifth. The skull is of the typical Mettad form, the antero-posterior curvature and the elongated palatine foramen being conspicuous features. Skull measurements are as follows : l. 30·5, b. 16, n. 13, p.f. 8, mls. 6.

There is no doubt that this rat belongs to a new variety of *Mus mettada*, but because of the great variability found among all races of rats, it does not seem wise to describe this single specimen as the " type " of the Madras Mettad.

We have also received rats from the following places in the Madras Presidency :—

Chingleput, Salem, Gopalpore, Bellary, Madura, Ootacamund, Travancore, Cochin, Tellicherri, Mangalore, Chitur.

Chingleput.

We have received the measurements, skins and skulls of ten rats of the *Mus rattus* type, of one *Gunomys bengalensis* and of a shrew from Lt.-Col. J C. Marsden.

Cpt. 1—

The ten specimens closely resemble one another ; in most of them the colour is yellowish brown, one or two are somewhat reddish. In no case is there any white on the abdomen. The

measurements and specimens show that the Chingleput rats are above the average in size and have relatively short tails. Judging from the measurements it appears that an average example would measure 200, 210, 30, 18.

Cpt. 2—

One large male specimen of *Gunomys bengalensis*, which in colour closely resembles a specimen from Buldana (Berar). The fur is sparse and contains short, slender bristles; it is greyish brown but is much lighter than usual, that of the lower surface being nearly white. The measurements show that it is a very large rat: 265, 177, 30, 20. This specimen, considered together with the specimen found near Madras city (Mds. 5), shows how erroneous it is to speak of the *Gunomys* of Southern India as being of a particular species, the members of which are approximately of a particular size.

Judging from the appearance of the skulls, the measurements of the rats from Chingleput seem somewhat high.

Salem.

Major R. K. Mitter has sent four examples of *Mus rattus*. They are all of the yellowish brown, dark-bellied type. The average of the measurements is approximately 170, 205, 30, 20. They resemble the *Mus rattus* of Madras city and many other places.

Gopalpore (Ganjam).

Mr. R. W Saldana has sent an example of the common house rat of this place. It is reddish brown above and pure white below. It measures 160, 197, 33, 20. It is a *Mus rattus*.

Madura.

Mr. B. S. Mullyer has sent a bandicoot and a *Mus rattus* from this place. The former resembles the bandicoot of Madras city in every way. The skull measures l. 58, n. 23·5, p.f. 11, mls. 10. The zygomata are broken, so that the greatest breadth cannot be measured. The nasals are 40 per cent. of the total length. The *Mus rattus* is a small specimen of the dark-bellied type such as is common in Madras city.

Bellary.

Mr. S. N. S. Iyer has sent two rats, one of which measures 163, 206, 31, 22, is dark brown and shows no white on the lower surface; the other, an immature rat, has a large patch of white fur on the breast. Both are of the species *Mus rattus*.

Ootacamund.

Major E. M. Illington has sent five measured specimens. One of these is a *Mus rattus*, two are bandicoots and two are mice.

Oot. 1, *Mus rattus*—

The specimen is a large one, measuring 193, 212, 31, 18. The brown element in the fur is of the reddish kind. The throat, chest and belly are covered with pure white fur.

Oot. 2—

This group includes two bandicoots which are different from any others received. Their measurements are—

237	212	50	25
162	125	39	18

The third molar tooth of the larger specimen is well worn, but the smaller specimen is obviously immature. The former differs from the bandicoots of Madras city in being considerably smaller and in possessing a shorter tail; it resembles them in the character of the fur and in the large size of the feet. In general appearance the skull resembles that of *Gunomys varius* of Rangoon. Indeed, the figure of the skull marked Rng. 64 on plate iii will serve as a representation of the skull of the bandicoot from Ootacamund, in size and general proportions, except that the nasal bones of the latter are somewhat longer.

The skull measures l. 48, b. 27, n. 18, p.f. 9·5, mls. 9·5. The nasals are 37·5 % of the total length, so that it is impossible to say which they most resemble, those of the Madras or of the Calcutta bandicoot.

Travancore.

Dr. N. Annandale recently collected seven rats from three separate places in Travancore. Six of them are of the *Mus rattus* type and closely resemble one another, the seventh is an immature *Gunomys*.

Three of the *Mus rattus* were caught in a forest bungalow at Tenmalai. One in the Zoological Gardens at Trivandrum and two at Kulatupuza. They are all of the white-bellied type and closely resemble the common rats of Tellicherri (Tli. 3) both in colour and size. Their measurements are—

150	175	30	19
162	213	33	20
171	202	32	21
176	208	30	23
204	197	33	23

The third molars of all are worn.

The small *Gunomys* measures 100, 59, 23, 14, the second molar is unworn, and there is no sign of the third; the specimen is therefore quite immature but it is unlikely that it belongs to the races of *Gunomys* found on the eastern side of Madras, for its fur is nearly black in colour, and the tail, ears and feet are very deeply pigmented. The *Gunomys* found near Madras city and at Chingleput, which

were very different from one another in size, were both of a light greyish brown colour. The skull of this small specimen from Travancore is of the *Gunomys* type.

Cochin.

Captain P. Atal has sent the measurements, skins and skulls of six rats from this place. Two of these are typical examples of *Mus decumanus*. These are the only specimens of *Mus decumanus* which we have received from the Madras Presidency. We have seen that there is strong evidence that this species cannot establish itself in Madras city. In Cochin *Mus decumanus* probably forms an isolated colony, the progenitors of which arrived in Cochin from a ship. There is no harbour at Cochin; sea-going vessels unload cargo by means of shallow draft boats from the shore. Communication between ships' rats and the shore must therefore be possible but of rare occurrence.

Chn. 1—

Type A.—Includes three rats of the *Mus rattus* type which resemble one another closely; the coloured element in the fur is yellowish brown. The under parts are of the dark type, the basal two-thirds of every hair being slate-coloured, the tip being yellowish brown. The measurements are—

167	200	31	25
175	225	37	25
187	212	34	25

Type B.—One specimen differs from the others in colour, though resembling them in size and proportions; in this the coloured element in the fur is a clear reddish brown.

Chn. 2—

Two typical examples of *Mus decumanus* measuring—

225	181	43	18
212	187	47	22

Tellicherri.

Mr. C. Lafrenais has sent the measurements, skins and skulls of forty-eight specimens of *Mus rattus*. The lengths of these are arranged in the diagram, text-fig. 7, which shows that rats of 170 mm. are in the majority, and that the collection contains a specimen of 205 mm. and another of 220. The tail-length varies considerably but is on the average about 120 % of the length of the head and body. The whole collection may be divided into three groups according to the colour of the fur.

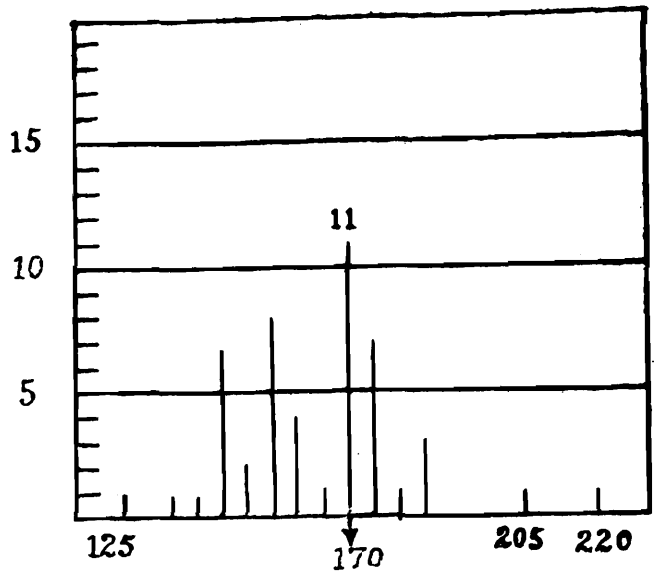

FIG. 7.—Diagram showing the length-frequency of 48 *Mus rattus* from Tellicherri (Lafrenais).

Tci. 1—

This includes two specimens which resemble one another very closely, but can be distinguished from the others at a glance. In both, the general tone of the upper surface is black, becoming dark brown on the sides and somewhat suddenly fawn-coloured below. The nose, ears and tail are black. The measurements are—

156	206	28	15
125	172	28	18

The smaller specimen is certainly immature. In both, the tail is remarkably long. It is most likely that these two rats were caught in the same house and formed part of the same family group. This assumption explains their resemblance to one another, and the wide difference from the others which they exhibit.

Tci. 2—

Includes eight specimens of the common reddish brown type of *Mus rattus* in which the ventral surface is dark, each hair being slate-grey with a reddish or yellowish fawn-coloured tip.

Tci. 3—

This includes the remaining thirty-eight rats. These cannot be distinguished from those of the former group by an inspection of the upper surfaces of the specimens. They can, however, be distinguished because the throat, breast and abdomen of all of them are covered with pure white fur. Unlike the white-bellied rats of some other districts such as Amritsar, Simla, Rangoon and Calcutta, none of them show a median coloured stripe on the breast. In some the fur of the lower surface is light lemon-yellow rather

than white, and in some the bases of the ventral hairs are light grey. In spite of this it would give a false impression to say that every intermediate stage can readily be found between the members of this and of the former group.

As regards the colour of the upper surface there is much variety; all are of a reddish brown colour but some are of that clear red tint which recalls the colour of the common English fox or squirrel. In some the black bristles are longer and more conspicuous than in others, so that the middle line of the back is of a much darker tone than the sides. Spines may be plentiful or absent.

Mangalore.

The District Medical Officer has sent thirteen *Mus rattus*, one young bandicoot, and two shrews. The specimens were received in alcohol without measurements.

Mng. 1—

Includes eleven specimens of the dark-bellied type of *Mus rattus*. Measurements of the spirit specimens show that they do not differ in size or proportions from the *Mus rattus* of many other parts of India; the average length is about 175 mm., and the average tail length about 210 mm. Since the collection is in spirit it is difficult to appreciate the colour of the fur; in most of the specimens it appears to be of the common reddish brown tint; spines and bristles are present in some, less conspicuous in others.

Mng. 2—

Includes two specimens which differ from those of the former group in being of the pure white-bellied type. These two specimens resemble one another very closely, except that in one of them the soles of the feet are deeply pigmented, while in the other they are light grey.

Mng. 3, *Bandicota sp.*—

This is a remarkable rat; unfortunately it is not fully grown but the third molar is cut and slightly worn so that it is not far from maturity. It must be regarded as a bandicoot because of the large size of its feet and the characters of the skull; it, however, differs from all other bandicoots met with, in being small and possessing a long tail. The measurements of the spirit specimen are 165, 185, 44, 22. The fur is coarse and bristly as in other bandicoots. The last centimetre of the tail is pure white. The skull closely resembles that of the bandicoot from Ootacamund; it measures l. 44, b. 25·5, n. 16, p.f. 8·5, mls. 10.

Chitur (N Arcot).

Cr. 1—

We have received from Mr. A. P. Fernandez measurements and skins of fourteen specimens of *Mus rattus*. The measure-

ments show that they vary from 160 to 197 mm. in length, but seven out of the fourteen are between 170 and 180 mm. The average tail measurement of these seven is about 215 mm. In colour they are all of the common reddish brown tint and resemble one another closely. In no specimen is there any white on the abdomen.

If the results obtained from these places in the Madras Presidency be considered together, they show that the races of *Mus rattus* which occur in the south do not differ from those of other parts of India. It is probable that the rats of Madras city are somewhat smaller, and those of Chingleput somewhat larger than usual. But at Tellicherri, Chitur, Travancore and other places the measurements of independent observers show that the size and proportions of the species are about the same as at Amritsar, Allahabad and Calcutta. The average length of the common rat throughout India is about 170 mm.; if large numbers of measurements are made in any place it will be found that there are more rats of nearly this length than of any other length, but that mature rats of 40 mm. less and 40 mm. more than 170 mm. are to be found. Among the rats of the south the colour and quality of the fur is as variable as among those of the north. The most obvious difference is in the fur of the ventral surface, which in some rats is coloured, in others pure white. It seems to the writer to be erroneous to say that there is no specific difference between a white-bellied and a dark-bellied rat. The intermingled distribution of the two kinds makes it almost certain that the dark-bellied form has, from time to time, given rise to the other throughout India; but the opinion that both must therefore be of the same indivisible species seems to be the outcome of a preconceived idea. Until recently, biologists have held it to be impossible for an animal or plant of one kind (variety or species) to give birth to offspring of another kind.

There is little doubt that dark-bellied rats occasionally give rise to white-bellied offspring; therefore the two forms must be of the same elementary species, though the difference in their appearance is obvious. This seems to have been the line of argument usually followed.

To say that the two forms are of one race because every intermediate grade between them could be found by a wide search, is to say nothing against their distinction, for an unbroken series of selected specimens could without difficulty be arranged linking together a small *Mus concolor* of 95 mm. with a large *Mus rattus* of 225 mm. To deny the distinction, because the two forms may interbreed, is to deny that there is any racial distinction among mankind.

It has, apparently, been proved by the experiments of De Vries and confirmed by others, that a plant of one species can produce offspring of different species. The same possibility is perhaps from time to time in all living things. In the light of this discovery we see that the dark-bellied rats and the white-bellied rats are of different elementary species, and that the former are continually giving rise to the latter in many parts of India

The following table shows that white-bellied rats are common in Southern India, and that they occur sporadically :—

Locality.	Number of rats observed.	Dark-bellied rats.	White-bellied rats.
Madras city	600	600	0
Chingleput	10	10	0
Salem	4	4	0
Gopalpore	1	0	1
Bellary	2	2	0
Ootacamund	1	0	1
Travancore	7	0	7
Cochin	4	4	0
Tellicherri	48	10	38
Mangalore	13	11	2
Chitur	14	14	0

In considering these figures attention must be paid to the relative situation of the places. White-bellied rats only were obtained at Travancore ; dark-bellied rats at Cochin ; both kinds at Tellicherri, the former being in excess ; both at Mangalore, the latter being in excess.

BURMA.

Rangoon.

In February of this year the writer was deputed by the Trustees of the Indian Museum to examine the rats of Rangoon. Owing to the large reward offered by the Municipal authorities of that city, a daily average of about 4,000 rats was then being received at the collecting stations. It was therefore possible within a week to become generally acquainted with the rat population of Rangoon.

The rats were being brought in from a wide area, from rice barns and riverside warehouses, from dwelling-houses, shops and stables in the heart of the city, and detached villages on the outskirts.

The greater number of rats received were brought in dead by the people of the town. Accurate information regarding the place of capture of rats so brought could rarely be obtained. A considerable number, however, were trapped by men in the service of the Municipality. These rats were brought to the collecting stations alive in traps which were labelled with the address of the house or shop from which they had been taken.

Certain features of Rangoon city must be briefly considered, for, as will be seen later, they have an interest bearing on the

nature of the rat population. There are six main thoroughfares in this city lying parallel with the river. They are crossed at right angles by a series of lesser streets which receive numerical designation. In any two of these streets the back walls of the houses are separated by an open space some twelve feet in width, a receptacle for rubbish, which is removed daily. These intervals between the rows of houses are spoken of as the " back drainage spaces."

An estimation of the numbers of the different species received at the collecting stations on six occasions was made. It must be remembered, however, that such estimations can only approximately represent the proportionate numbers of the different species actually present in the city. Doubtless some sorts of rats are to be captured more easily than others. The distribution of the several species must differ in certain parts of the town; for example, the specimens of *Mus decumanus* generally came from riverside buildings.

The groups into which the rats have been here divided are, from the systematist's point of view, of the widest sort. *Mus rattus* and *M. concolor* (the miniature *rattus* of Burma) have for the purposes of this estimation been included in one group, for although this group contains at least two races, numerous individuals were met with which in size were intermediate between the two.

In the group of *Gunomys* are included at least two well-marked races, though many more would be recognised by some systematists. Care was taken to exclude all but adults from the reckoning, for the half-grown *Mus decumanus* is often difficult to distinguish from a young *Nesokia* by superficial examination; the same precaution was necessary in dealing with the *rattus* group.

Occasions.	*Mus rattus* and *concolor.*	*Mus decumanus.*	*Gunomys.*	Mice.	Shrews.
1	49	13	26	24	25
2	245	6	73	116	14
3	29	14	14	0	0
4	122	6	35	21	21
5	144	12	26	97	23
6	66	10	18	25	83
	652	61	192	283	166

Rats were received at the collecting stations at specified times. All the adult rats received at one time were counted on six occasions. Those received on each occasion have been shown separately, as the numbers differ considerably.

The rattus *group.*

After a brief examination of any large number of rats received at a collecting station, it was easy to separate out those belonging to the species *Mus decumanus* and *Gunomys bengalensis*, as well as the mice and shrews. But when these had been set aside, a large number remained which resembled one another in having long pointed snouts, long tails, large ears and six foot pads, one of which was much elongated; that is to say, in possessing those features well known to be characteristic of *Mus rattus*. Among many hundreds examined, however, not one was found which in colour and size together resembled any of the Indian rats.

A large number of measurements of the rats of this group were made, care being taken that only adults were selected, that is to say, those with prominent teats or testes. The teats of any seemingly adult female rat appear in one of three conditions. Firstly, they may be very small and hidden among the fur; secondly, they may be larger and surrounded by sparse fur, so that they are apparent without search; thirdly, they may be even more prominent and at the same time red. The first and second conditions cannot be confused. Female rats with teats in the first condition (very small and hidden among the fur) were considered to be maidens and were rejected, even though they were in some cases larger than those having teats in the second condition. Rats with teats in the second condition were considered to have borne young ones at some time. Those in the third condition were advanced in pregnancy. Only those in the second and third condition were regarded as adults and measured. Examination of the other generative organs confirmed these opinions. Among males those with testes projecting far behind the anus were counted as adults. It has been asserted that the testicles of rats enter the scrotum only during the rutting season. This view does not, however, commend itself, for it has been shown beyond doubt that in India rats breed all the year round, nor does it seem possible at any time to find an old male of the *rattus* group devoid of prominent testicles. For the purposes of these measurements, all rats of whatever size devoid of prominent testes were rejected as immature. It was very necessary to select undoubted adults for measurement. Among the group there seemed to be at least two races, a small dark-bellied race and a large white-bellied race, but immature members of the larger race were sometimes smaller than mature members of the smaller race.

A large number of rats selected with these precautions were measured immediately after death by chloroform. The writer measured sixty of them, selecting equal numbers of the two races. The measurements arranged in series are shown on plate v; although there is some intermingling towards the middle of the series, nearly all those of the dark-bellied type are in the lower half, those of the other type being in the upper half.

In order to illustrate the separation of the two races more fully, 500 adult members of the long-tailed races were subsequently

measured under the supervision of Captain Kelsall, I.M.S. In making these measurements no selection was made; all adult rats if caught alive and if of the long-tailed races were measured until 500 records were obtained. It was expected that by representing the measurements graphically (in the manner described on page 17) a double humped curve would be produced owing to the fact that rats of 120 and of 150 mm. length would be in the majority. This expectation was not realized, for at the time of the experiment the white-bellied rats were not frequently caught, and only sixteen of them were included among the 500. The diagram, however, clearly shows the separation of the two races, for these white-bellied rats are not distributed irregularly among the 500, but are crowded into the upper half of the series. There are, however, two specimens measuring 115 and 120 mm. in length, which are both white-bellied and small, and one specimen measuring as much as 170 mm., which is dark-bellied. The races are none the less separate because of these exceptions, for of 139 rats which measured about 120 mm., only one is white-bellied, while of four which measured 150 mm., all are white-bellied.

Rng. 1, *the small race long known as* Mus concolor—

This rat has been recognised by all writers to be a miniature of the *Mus rattus* type. It forms at least 50 % of the total rats of Rangoon and at least 75 % of the true house rats. The proportions of the race are illustrated in the diagrams, text-fig. 8 and plate v. In length they vary from about 100 to 140 mm., the mean of the race being close to 120 mm. In tail length they are very variable, the tail percentage varying from 100 to 135, with a mean of about 117. The foot is about 20 per cent. of the length. In colour these small rats show the same types as are met with among the larger *Mus rattus* of India. Any thousand of them will show the fulvous, the rufous, the melanotic, and white-bellied varieties. The following types will be described:—

Type A—The brown type.—Rats of this kind resemble in colour the common brown type of *Mus rattus* found throughout India. The hairs of the back are slate-grey in the basal half or two-thirds, their apical portions being of some shade of brown, reddish in some rats, yellowish in others. Those hairs which are longer than the majority are not only grey and brown but have black tips; a few of the longest hairs—the bristles—are black in most of their length. In addition to these are certain hairs which are conspicuous because they are flattened and of a light grey colour; these may have brown or blackish tips; these "spines," as they are technically called, are plentiful in some specimens, scarce or absent in others.

The brown colour produced by this mixture of hairs becomes lighter on the sides and passes gradually into the light brown colour of the ventral surface. The short hairs of this surface are grey in the basal half, brown in the apical half, the brown being often yellowish, sometimes reddish.

Type B—Black variety.—These are not so common, pure black ones making up less than one per cent. of the whole; semi-melanotic specimens are more common. The melanotic and semi-melanotic examples of *Mus concolor* show exactly the same gradations of colour as are exhibited by *Mus rattus* (Hossack [1, page 17]).

Type C—The white-bellied type.—The writer did not himself meet with any adult rats of 120 mm. length of the white-bellied type. The 500 measurements received from Captain Kelsall show, however, that they are to be found; each measurement was accompanied by a statement that it was of a rat which was sexually mature. These small white-bellied rats might be considered as exceptionally small members of the race next to be described.

The figures beneath the horizontal line in text-fig. 8, which show the numbers of white-bellied rats of each measurement which are

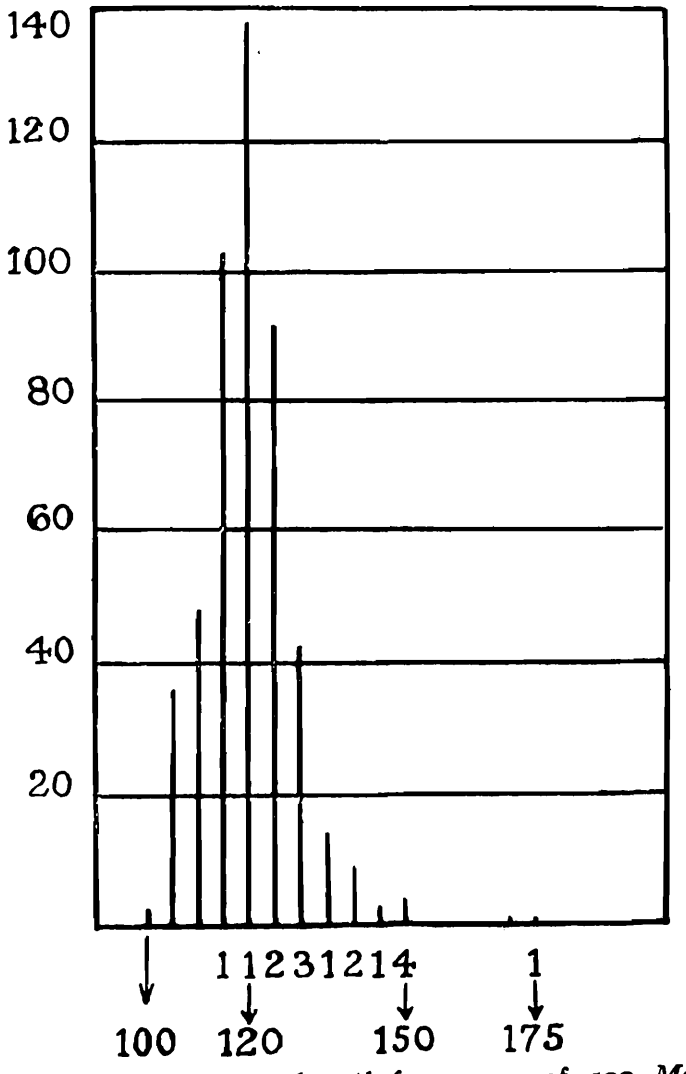

FIG. 8.—Diagram showing the length-frequency of 500 *Mus concolor* and white-bellied *Mus rattus* from Rangoon (Kelsall).

present, seem to indicate that some of them, for example the one measuring 115 mm., should be regarded as white-bellied *Mus concolor*. A point of distinction is always present in the case of females, for no exception was found to the rule that the teats in *Mus concolor* were eight in number ($\frac{8}{8}$). The dark-bellied rat shown as measuring 170 mm. length was probably a recent

importation of the common *Mus rattus* type. There is one interesting white-bellied rat measuring 147, 153, 30, 18 which has teats of the *Mus concolor* formula ($\frac{2}{2}$).

Measurements of five chance-taken skulls of adult Mus concolor.

Length of rat.	Skull length.	Breadth.	Nasals.	Pal. for.	Molars.
108	27·5	15	10·5	6	5
	100	54·9	37·4		
110	28	15	11	6	5
	100	53·6	39·2		
104	26	13	10	5·5	4·5
	100	50	38·4		
123	28	14·5	10·5	6	5
	100	51·8	37·5		
117	28	14	10·5	6	5
	100	50	37·5		

These skulls show no difference in their proportions from the *Mus rattus* type.

These three divisions A, B and C of Rng. 1 might be more finely subdivided. A large number of mixed *concolor* taken from all parts of the city could be arranged so as to show "intermediates" not only between the subdivisions but between the divisions. In spite of this, divisions and subdivisions are definite entities, for rats found together in one house are nearly always of the same type. Melanotic or semi-melanotic *concolors* are comparatively rare, but they are caught, not singly, but three or four at a time.

Rng. 2—

A race of the *Mus rattus* type, the members of which are of medium size, have white under parts and comparatively short tails of uniform dark colour; the females have teats almost invariably $\frac{3}{3}$.

The peculiarities of this race are illustrated in the diagram (plate v). The mean length of the race is about 145 mm. The tail length averages about 105 per cent. of the length. The zigzag line *Ct.* shows that the percentage is lower in this race than in *concolor*. The teats were counted in eight mature females; in six of them they were $\frac{3}{3}$, in one $\frac{2}{3}$, in another $\frac{2}{2}$. As regards colour they all agree in possessing white under parts sharply defined from the brown upper parts. In most of them the white is pure, but grey median breast stripes of varying width and length are not uncommon. In a few specimens all the ventral hairs have light grey bases and white tips. As regards colour of the upper parts, perhaps the commonest type is a dull greyish brown almost exactly like a

typical *Mus decumanus*. There is no darkening in the middle line due to excess of black bristles.

There are many other types; some few are as red as any that we have obtained from any part of India, that is to say, as red as an English squirrel. Numerous intermediate types occur. The soles of the feet are unpigmented, light grey, or mottled, the upper surface is covered with white hairs, sometimes with light brown hairs.

This description is based on an examination of some hundreds collected from different parts of the town. The rats from any one house, however, resemble one another very closely as a rule. Together they form a definite race composed of innumerable "family groups" which are in some cases as distinct as the species of modern writers.

It is difficult to find a suitable name for this race. Several white-bellied rats with unicoloured tails have received specific names in the Oriental region, especially from countries south of Burma. Among these *Mus jalorensis*, judging from the description, comes nearest to an average member of the Rangoon race. The feet of the "type" *Mus jalorensis* are described as dark brown above with blackish soles. Individuals with deeply pigmented feet are rare among the Rangoon race. It is most improbable that one chance-taken specimen from Rangoon would closely resemble the type of *M jalorensis*. It is, however, certain, in my opinion, that if the "type" of the rat of Jalor were sent to Rangoon, many individuals exactly agreeing with it could be selected from any thousand of the rats of that town. This does not justify the appellation of the name to this heterogeneous race, for it seems equally certain that specimens agreeing exactly with some other "types" of established species could be selected from among ten thousand of the Rangoon race. A similar selection might be made in Singapore or other large towns.

In the proportions of the skull the race does not differ from the *Mus rattus* type so far as can be shown by measurements of five chance-taken adults.

Length of rat.	Skull length.	Breadth.	Nasals.	Pal. for.	Molars.
140	33·5	16·5	12	7	6·5
	100	50	35·5		
151	34·5	18·5	13	7	7
	100	53·5	37·6		
153	35·5	18	14	7·5	7
	100	50·7	39·4		
163	36	18·5	14	7	7
	100	50	38·8		
170	37	18·5	14	8	7·5
	100	50	37·8		

The tails of these rats are of a dark greyish brown colour, of exactly the same shade above and below.

Rng. 3—

One young specimen was obtained which measures 113, 97 (tip broken), 28, 16; this exactly resembles many of the immature members of the group Rng. 2, but differs from them in that the under side of the tail is completely devoid of pigment. In this respect, therefore, it resembles *Mus jerdoni*, *niveiventer*, *vicerex*, *bukit*, *rapit*, etc. It is regarded as a sport born from one of the race Rng. 2, for it is unique among many hundreds of rats which it otherwise resembles, and it is too young to be an importation. Its immaturity is shown by its small size and large feet, also by the fact that the third molar is not cut.

Rng. 4, *Gunomys varius*—

Rats of this species were called "bandicoots" by the officials in charge of the rat-catching operations. This name was a good one, for, besides closely resembling bandicoots in the bristly nature of their fur, these rats have skulls which are hardly to be distinguished from those of small specimens of *Bandicota nemorivaga*, but considerably different from *Gunomys bengalensis* (plate iii). In general appearance, however, they differ from bandicoots in being less in length but relatively stouter, and in having shorter tails and shorter feet, peculiarities which belong to the *Gunomys* type.

Probably not less than 10 % of the rats of Rangoon belong to this species. Estimations made at the collecting station may show figures somewhat less than this, but like the bandicoots of Madras city this outdoor rat must be difficult to capture. It is too large to enter cage traps with ease. Questions as to the place and mode of their capture almost always met with the same response, "killed with a stick in a back drainage space."

It seems that this rat has never been noticed in Burma before although it has been long known from countries further south. It can be traced back in scientific literature as far as 1824, when Horsfield discovered it in Java and published a long account of it with an excellent engraving [14]. It was named *Mus setifer* by its discoverer, who considered it akin to *Mus giganteus*, the name which used to be applied to the Indian bandicoots. Cantor recorded it under the same name from Penang [15], and held the same view of its affinities. Blanford, in the *Fauna of British India*, 1891, regards *Mus setifer* as a doubtful synonym of *Nesokia* (*i.e.*, *Bandicota*) *nemorivaga*, but he mentions that the Burmese form of *Nesokia bengalensis* is larger than the Bengal form. This statement may have arisen from the presence of *Gunomys varius* in Burma.

In 1907 this rat appeared as *Gunomys varius*, sp. nov. The author who gave it this name regarded it as the Malayan representative of *Gunomys bengalensis*. He states clearly, "This is *Mus setifer*, Horsfield." The species is a most interesting one,

for in the relative proportions of body, tail and feet it is of the *Gunomys* type, but in its large size, the character of its fur and in the proportions of its skull it approaches the bandicoot type. It will be shown, firstly, that this common Rangoon rat is *Gunomys varius*; secondly, that it is more or less intermediate between *Gunomys* and *Bandicota*.

Although large numbers of these rats were examined daily, only four selected specimens were taken to Calcutta. These are all adults, they include large (A), medium (B) and small (C) specimens, and one colour-variety of a light buff colour (D). The large specimen happens to be of the same size as the "type" of *Gunomys varius*.

	Length.	Tail.	Hind foot.	Ear.
Type of *G. varius* (*Ann. Mag. N H.*, 1907, p. 205).	266 100	197 74	40 15	19
A . .	265 100	208 80	39 14·3	22
B	230 100	180 78	36 16	20
C .	205 100	165 80	35 17	20
D (buff variety)	260 100	195 75	49 19	22 ..
Average percentage in *Gunomys bengalensis*.	100	80	17	.
Ditto in *Bandicota nemorivaga*.	100	95	19	

These figures show that the rat we are dealing with is *Gunomys varius*, and that in its proportions it is more nearly a *Gunomys* than a bandicoot.

In the character of the fur our specimens exactly agree with the description of the "type." The upper surface shows a mixture of black and creamy buff-coloured hairs, with a large number of long black bristles, the tail is covered with relatively long hair. In the proportions of the skull the similarities to the type are not less close.

	Condylo-basal.	Greatest breadth.	Nasals.	Mol. alv.	Pal. f.	Dia.	Frontal height.
G. varius type	48 100	26·7 55	16 33·3	8·5	10	16·3	15·5
A	50·5 100	29 54·5	16·5 32·7	9	11	17	16
B	47·5 100	broken	16 33·6	8	9·5	15	15
C	44 100	25 56·8	14·5 33	8	9·5	14	13·5
D	53 100	29 54·4	17 32	10	10·5	17	15·5
Bandicota nemorivaga.	100	54	36·5				
Gunomys bengalensis.	100	60	29				

These figures also show that our specimens belong to the species *Gunomys varius*, but that this species resembles *Bandicota* in the proportions of the skull. The similarity is also shown in plate iii.

Rng. 5—

A sport from *Gunomys varius*, differing from the type in being of a light buff colour and in possessing much larger feet.

Rats of this type were occasionally received at one of the collecting stations. The writer obtained one adult specimen and saw two young ones, survivors from a litter of five. The measurements of the adult are given under Rng. 4, specimen D. It generally resembles *Gunomys varius* but every hair on its body is of a light buff colour. The abnormal size of the hind feet is also very noticeable; in an equal sized or slightly larger specimen the foot is 38 mm., in the buff specimen it is no less than 49 mm. The two young ones also had extraordinarily large feet, but relative proportion of the feet is usually somewhat enhanced in young rats.

These buff-coloured rats are not regarded as an established species but rather as a sport from *Gunomys varius* which has met

with some slight temporary success in the struggle for existence owing perhaps to their being prepotent and of exceptional fertility. Their colour must be a disadvantage to them, rendering them conspicuous.

This opinion is favoured by the fact that among some thousands of the smaller *Gunomys bengalensis* which were observed in Calcutta by Dr. Hossack were two specimens which were of exactly the same light buff colour; they do not, however, possess exceptionally large feet. These are evidently sports from *Gunomys bengalensis*.

Rng. 6—

A tailless sport from *Gunomys varius*.

This rat was preserved as a pet at one of the collecting stations. The official in charge told me that he had reared it because of its strange abnormality. It showed no trace of the lost appendage, and even when quite young no scar was visible. It was evidently a congenital peculiarity. Such a sport would have little chance of becoming established, as it would probably be shunned by other rats.

Rng. 7, *Gunomys bengalensis*—

Rats of this species make up about 15 % of the rat population of Rangoon. At first sight a collection of these rats appears to exactly resemble a collection of the same species made in Calcutta. The proportions of body and skull are the same in the two cases. They show the same range of variation. The first four adults which came to hand were measured; they were part of a large batch which were captured in a stable.

Length.	Tail length.	Hind foot.	Ear.
162	135 (83 %)	35	19
161	129 (80 %)	34	20
169	124 (79 %)	36	20
169	119 (73 %)	34	21

In colour these four were as closely alike as in size, but it would not be accurate to say that they represented the type of *Gunomys bengalensis* present in Rangoon. They may be referred to as type A of Rng. 7.

Another specimen was selected—type B. This measures 184, 150, 35, 30. The fur of this rat contains much longer bristles and is of a dark reddish brown colour. Rats of type A have dull greyish brown fur and short bristles.

There was another type—C—of which three specimens were obtained on two occasions, but all three were from a village named Dalah on the outskirts of the city. It happens that these three are of nearly the same size as those of type A.

Length.	Tail length.	Hind foot.	Ear.
167	136 (81 %)	32	17
163	137 (84 %)	34	18
158	140 (82 %)	34	20

They differ from the others in that the fur is nearly devoid of bristles and is soft and silky to the touch. They also seem to have broader skulls, but more material would be necessary before this important point could be proved. It would be possible to enumerate many other types. These, however, were the most distinct that were met with during the few days of my visit.

After describing these types it is perhaps necessary to explain the statement that the species *G. bengalensis* is common to Rangoon and Calcutta. If two chance-taken specimens, one from each place, be laid side by side, it is most unlikely that they would resemble one another closely in colour, size, or proportions, yet a single specimen from one place could be very closely matched by searching among large numbers of specimens from the other place. The rats of type C, however, were not quite like any of the Calcutta specimens; they were more like the soft-furred Punjab type. In my opinion, the types A, B and C, which are merely three of a large number which could be made from the mole-rats of Rangoon, show differences at least as great as those which are used to separate "species" at the present day. By searching among a collection of many thousands taken from all parts of the city there is no doubt that every gradation between each type could be found. The types are none the less separate because of this, however. If, for example, twenty mole-rats are caught together in one stab e or warehouse, they will almost always be of the same type, and only show slight individual variations amongst themselves.

Rng. 8—

A family group or localized race of *Gunomys bengalensis* characterised by the pure black colour of its members.

These are considered separately as, owing to their black colour, they were remarkably different from all others of the species. Individuals intermediate between the black and the normal greyish brown forms were not met with. The occurrence of this group is of such interest that it will be described in detail. It shows the extent to which mole-rats have associated themselves with man.

It has been recently proved that both in Calcutta and Dacca these rats occur in large numbers not only in stables and out-houses but also in shops and dwelling-houses. Some doubt perhaps still remains as to whether this occurrence may not be due to a temporary and fluctuating migration of these rats, which have long been known as dwellers in the fields. In Rangoon, however, the evidence was clear that they live continually and propagate themselves in dwelling-houses in the heart of the city.

A case of plague having occurred in a certain house (No. 65 Maung Khyine Street), a number of traps were set in that house by the Municipal rat-catchers; on the following day these traps were brought to the collecting station containing five pure black *Gunomys*. Traps were set in adjacent houses, and on the next night from house No. 65 one other was obtained, and from the adjacent house, No. 66, three precisely similar rats were obtained. Again on the following night one more was obtained from house No. 66. After this no more were obtained.

The writer visited these houses and noticed where the traps were placed. Both houses were built principally of wood, and consisted of upper and lower rooms, the former being closed and unoccupied. Number 65 was a tailor's shop and dwelling-house. Number 66 was a laundry. The houses were divided by a double partition of thin planking separated by a narrow space. The floors were tiled. In front the houses opened directly on to the street, behind on to the "back drainage space."

The ten rats taken in these two houses could be recognised at a glance by their pure black colour from any other *Gunomys* taken from other parts of the city. They must have been closely related as a family to one another. It seems much more likely that they had been bred where they were found, than that they had migrated together as a family from the fields. If the more probable view is the correct one, it can be asserted that these *Gunomys* rear their young within the houses in the manner of house rats. The houses in which they were found had no adjacent garden or waste space available for the making of burrows.

The "back drainage space" was, owing to the daily cleansing, as unsuitable for the rearing of a field rat's family as the busy street itself. No one who has seen traps from houses brought in daily, containing *Gunomys*, mature, immature and pregnant, can doubt that these rats, which are perhaps the commonest field rats in India, have become permanent parasites of man within some of the larger towns.

Of these ten rats, four were brought to Calcutta. Their measurements are as follows:—

Length.	Tail length.	Hind foot.	Ear.
203	170 (83 %)	36	21
193	158 (81·8 %)	38	21
177	141 (80 %)	35	20
158	130 (82 %)	32	20

Only the first two were fully mature.

The figures show that these black rats resemble one another not only in their colour but also in being well above the average in length, and very closely alike in their tail index. (Hossack gives for fifty mixed *Gunomys bengalensis* in Calcutta range in length from 150—205, with an average of 182. Tail index range from 69—94, average 81·1.)

The skull proportions of these black rats agree closely with one another and differ considerably from the average of the species.

Length.	Breadth.	Nasals.	Pal. for.	Molars.	Remarks.
44·5	25·5	14	9	8	Mature.
100	57·3	31·4			
43	25	13·5	9	8	Mature.
100	58	31·4			Young.
41	24	13			
100	58·5	31·7	9		

For twenty skulls of *G. bengalensis* from Calcutta, Hossack gives the following :—

Range of length	37 to 44	average 39·6
$\frac{\text{Breadth}}{\text{Length}}$	58·2 to 63·3	,, 59·8
$\frac{\text{Nasal length}}{\text{Length}}$	28·2 to 31·8	,, 29·3

Thus as regards breadth two of the three are less than the least of the twenty Calcutta skulls. As regards length of nasals all three are very close to the highest value found among the Calcutta specimens.

The members of this group have therefore no less than four peculiarities: blackness of fur, increased size, narrowness of skull, and increased length of nasals.[1]

It seems that the last three of these peculiarities are elsewhere associated, for under the heading "Buldana" will be found a description of a local race of *Gunomys* which shows the same three peculiarities. The bandicoots also illustrate this correlation.

[1] Two more of these black mole-rats have been recently obtained from Rangoon; they show the same peculiarities.

Rng. 8 *A*—

A few days after the capture of these ten melanotic *Gunomys*, a man brought in three somewhat similar rats from another part of the town. These were also pure black specimens of *G. bengalensis*, but they were different from the others in that the muzzle, and to some extent the ears, were scantily pigmented. These parts were consequently of a livid pinkish colour, and gave to their possessors an appearance remarkably different from the others, the noses and ears of which were very deeply pigmented. It was not possible to trace their exact habitat; being somewhat decomposed they were not kept.

It seems likely that these two melanotic varieties had arisen quite independently of one another, although in the same town.

UPPER BURMA.

The rats of Upper Burma resemble the rats of Rangoon so far as has been ascertained. The common dark-bellied *Mus rattus* of India is not common in Burma. In place of it we find the small *Mus concolor* and a white-bellied race of *Mus rattus* the members of which, in Rangoon and perhaps throughout Burma, are on the average smaller and have shorter tails than *Mus rattus* of the Indian Peninsula.

Myitkyina (Bhamo).

We have received, through Dr. L. Fink, a number of specimens from Kamaung, Mogaung, Mankin and Myitkyina. The first specimen sent was a typical *Mus decumanus*. It has been stated that China is probably the home of this wandering species: since Bhamo is close to the borders of China, other specimens were awaited with interest; when received they were found to consist of twenty typical *Mus concolor*, one other immature *Mus decumanus*, two white-bellied *Mus rattus*, and one dark-bellied *Mus rattus* of normal size. The progenitors of the *M decumanus* probably arrived by the steamboats which ply between Rangoon and Bhamo. The examples of *Mus concolor* are indistinguishable from those of Rangoon; some of them have white-tipped tails; of four specimens from Kamaung, sent by Captain Gandoin, two show this peculiar character.

Mr. Hefferman has sent two *Mus concolor* from Lower Chindwin; these measure 122 and 131 mm. in length; one of them has a white-tipped tail. This character seems specially common among *Mus concolor* in Upper Burma. It has been previously mentioned that it occurs sporadically and more rarely in India among the genera *Mus*, *Gunomys* and *Bandicota*.

Captain Gandoin has sent a white-bellied *Mus rattus* from Yamethin; it measures 150, 200, 26, 20. We have also received a large number of measurements from Mandalay, but in the absence of specimens little can be said in regard to them; it is probable that *Gunomys varius* occurs there, and that *Mus concolor* is common.

WEST AUSTRALIA.

We have received an interesting collection of rats from Mr. T H. Lovegrove of the Department of Public Health in Perth. These were all caught in the port of Freemantle either from the wharves or ships. The collection contains eight *Mus rattus* and two *Mus decumanus*. The two latter and one black *Mus rattus* are labelled "Freemantle wharves." The other seven *Mus rattus* are labelled "S. S. *Sultan.*" They were probably taken during one of the periodical destructions of vermin which are sometimes carried out on ships. In regard to *Mus decumanus* nothing need be said; they are quite indistinguishable from others of the species obtained in Calcutta and Rangoon. The seven rats from the ship are most interesting. Among them are to be found examples of the three chief kinds met with in India. Four of them are black, three are brown and indistinguishable from one another as to their upper surface, but two of them are white-bellied and the other is brown-bellied. The three kinds are distinguishable from one another at a glance, but each is indistinguishable from the corresponding kind found in India, at a port such as Bombay, or an inland town such as Cawnpore. *Surely it cannot be supposed that these three kinds have each arisen separately and subsequently become associated with one another so as to have distributed themselves widely in the intermingled state in which they are found.*

The measurements of the seven rats are interesting. They seem somewhat higher than might be expected from the appearance of the specimens, at the same time the tails seem somewhat short. The measurements have probably been taken from the first ring of the tail and not from the anus; if so, 10 mm. should be subtracted from the lengths and added to the tail lengths in order to bring the measurements into line with our others. The measurements are all by the same hand and so may be safely compared *inter se*. As has been noticed both at Cawnpore and Calcutta, the black rats are smaller than the brown ones.

Length.	Tail length.	Colour.	Remarks.
150	190	Black	Immature.
193	190 br.	,,	Mature.
195	230	,,	,,
210	225	,,	,,
215	230	Brown	Brown-bellied.
218	230	,,	White-bellied.
220	235	,,	,,

We have also obtained a specimen of the Australian rat *Hydromys fulginosus*.

BOMBAY.

The rats of Bombay have been fully dealt with by Captain Liston and the workers of the Plague Commission. Judging from several specimens lent by the Bombay Natural History Society, I conclude that the three kinds of *Mus rattus*, the black, the brown and the brown white-bellied, are commonly found there.

In concluding this systematic account I must express my thanks to all those gentlemen who have contributed measurements and specimens. Thanks are especially due to Captain G. I. Davys, I.M.S., who, aided by his assistant, H. A. Khazan Chand, has sent over one thousand. The extent of their work can only be properly appreciated by any one who has measured and skinned even twenty rats in a hot climate.

Although I have not always agreed with Dr. Hossack's conclusions, I have never been able to dispute his observations; and I must repeat my thanks to him for introducing me to the subject, and for establishing the precedent of examining rats in large numbers.

Finally, my thanks are especially due to Dr. Annandale not only for the interest he has shown in the work day by day but for his steadying influence among the perplexity of sports and races, as well as for the liberal way in which, as Editor of the *Indian Museum Records*, he has allowed me to express views which are not quite in accordance with museum traditions.

APPENDIX I.

THE BEARING OF THE ENQUIRY ON PLAGUE DISSEMINATION.

Since it has been recognised that rats are important factors in the dissemination of plague, the attention of many has been turned towards these rodents. In consequence it became evident that we knew little of the distribution of their several races in India, and that some of the hitherto accepted statements in regard to them must be looked upon doubtfully. It was shown that mole-rats, which were considered solely as dwellers in the fields, could, in some circumstances, become intimately associated with man; while in other circumstances house rats might establish themselves in the fields. Doubt was felt as to the extent to which the wandering grey rat (*Mus decumanus*) prevailed in India. It was shown that the races of rats infesting Calcutta and Bombay were remarkably different from one another, so that it became desirable to compare them with those of other ports. The present enquiry is an attempt to throw light on some of these questions.

The extermination of rats has been largely carried out in many districts in India as a means of directly diminishing plague mortality. Such measures are perhaps partly of an experimental nature; the question of their efficacy cannot be discussed here,—