

of water containing much organic or even inorganic material in solution.

In the experiment noted above 1—300,000 copper sulphate was fatal to small fish. On the other hand, 1—200,000 is stated by Perry and Adams [4] not to be injurious to minnows and gold fish.

Experiments to test the action of copper sulphate in pure water.—A copper vessel was thoroughly cleaned and filled with tap water. It was covered and allowed to remain undisturbed for 24 hours. 1, 5 and 10 cc. were removed in sterile pipettes and added to nutrient bouillon. In each case marked turbidity occurred after incubation. The action of storing water in clean copper vessels therefore does not appear to cause anything approaching sterile conditions.

A single loopful of typhoid emulsion was added to each of a series of tubes containing sterile distilled water and sterile copper solutions of various strengths. At the end of four hours a single loopful was taken from each tube and added to nutrient bouillon tubes. These were then incubated for 24 hours. The results were as follows :—

Tube.	After 24 hours, incubation at 37° C.
Distilled water control A	... Marked turbidity.
Distilled water control B	... " "
Copper sulphate 1—100 No growth.
Copper sulphate 1—500 " "
Copper sulphate 1—1,000 " "
Copper sulphate 1—5,000 " "
Copper sulphate 1—10,000 " "

In pure water then my experiment confirms the results given by Rideal and Baines, in that copper sulphate 1 in 10,000 has a sterilising effect upon typhoid bacilli.

Experiments to test the action of copper sulphate in the presence of organic matter in solution—Inhibition of growth.—A series of flasks of nutrient bouillon received, with the exception of the control, sufficient of copper solution sterilised at 120°C. to produce the dilutions given below. Each flask was then inseminated with a single loopful of typhoid emulsion and incubated at 37°C. for 24 hours. The results were as follows :—

	Appearance.	Growth.
Untreated broth Marked turbidity.
Copper sulphate 1—200	... Copious green precipitate and green supernatant fluid	... Clear.
Copper sulphate 1—400	... Green precipitate and green fluid	... " "
Copper sulphate 1—5,000	... Nil	... Marked turbidity.
Copper sulphate 1—100,000	... Nil	... " "
Copper sulphate 1—1,000,000	... Nil	... " "

Copper sulphate in a highly organic solution had therefore a marked inhibitory effect upon the growth of the typhoid bacillus.

Destruction of bacilli.—Four flasks of typhoid bouillon received each sufficient sterile copper solution to make the strengths of copper noted below. The flasks were agitated and left undisturbed at room temperature for four hours. A single loopful from each was then added to a

tube of nutrient bouillon. The results were as shown :—

	Result of inoculation of broth tube.
Treated with 1—250 copper sulphate	... Turbidity.
Treated with 1—500 copper sulphate	... " "
Treated with 1—1,000 copper sulphate	... " "
Treated with 1—5,000 copper sulphate	... " "

Copper sulphate solution 1 in 250 in four hours did not destroy all typhoid bacilli in organic matter of the kind experimented with.

As a disinfectant in the ordinary sense of the term copper sulphate does not seem to be very efficient.

REFERENCES :—

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- * Schumberg and others "Jour. of State Medicine," Oct. 1900, p. 721.
- * Perry and Adams "Rivers Pollution, Connecticut, 4th Report."

THE RATS OF INDIA.

BY W. GLEN LISTON, M.B.,

CAPTAIN, I.M.S.,

Plague Research Laboratory, Bombay.

I APPEND a description of the rats of India extracted from a paper on the Indian Species of Genus Mus. By Oldfield Thomas, F.Z.S., British Museum, in the Proceedings of the Zoological Society of London, May 3rd, 1881.

With regard to methods for measuring and preserving specimens of mammals, I would refer the reader to Vol. XIII, pp. 108 to 112 of the Bombay Natural History Society's Journal.

SYNOPTICAL TABLE OF INDIAN RATS.

1. Hind feet with six well-defined foot-pads.
 - A. Large, 4½ to 9 inches; last hind foot-pad elongated—rats.
 - a. Whole of tail covered with short hairs upperside of tail dark-coloured. 8-12 mammæ.
 - α. Tail dark above and below.
 - a. Tail shorter than head and body; 10—12 mammæ; hind foot 1.5—1.7. 1. *M. decumanus*.
 - B. Tail longer than head and body.
 - a. Anterior edge of zygoma-root with a strongly marked rounded angle above. 10—12 mammæ; hind foot 1.2—1.45. 2. *M. alexandrinus*.
 - b. Anterior edge of zygoma-root nearly perpendicular; hind foot .95—1.05. 3. *M. fulvescens*.
 - B. Tail sharply bicolor, dark above and white below. 8 mammæ.
 - c. Back bright rufous; tail much longer than head and body; hind foot 1.0—1.15 4. *M. jerdoni*.
 - d. Back yellowish grey; tail barely longer than head and body; hind foot 1.0. 5. *M. niveiventer*.
 - b. Distal third of tail with longer hairs, white above and below 6 mammæ.
 - c. Hind foot 1.2—1.35. 6. *M. blanfordi*.

MUS DECUMANUS.

M. decumanoides.
M. brunneus.
 Hab. *Commpolitan.*

No description is needed of this too well-known rat. It may always be distinguished from any specimen of *M. alexandrinus* by its short tail and ears, and its larger size. The following are the chief dimensions of a full-grown male: Head and body 8.3, tail 7.1, hind foot 1.6, ear-conch 0.7, muzzle to ear 1.85.

The type of *Mus brunneus*, Hodgs., is certainly a specimen of this species, as might be expected from his description. Though most certainly not indigenous, Mr. Blanford tells me, that these rats are found on all the rivers of India, being carried up by the boats, and that by this means they might easily have got into the valley of Nepal, by way of the rivers Gunduck and Coosy.

We now come to the truly indigenous Indian species of *Mus*. The first one that claims our attention is the common house and tree-rat of the whole of India, the *Mus rufescens*, Gr., of Blyth and other authors. After careful comparison of a very large number of specimens from all parts of India, I have come to the conclusion, that this rat is only a southern offshoot of that form of *Mus rattus* commonly known as *M. alexandrinus*. In India we find three just distinguishable varieties of it:—(1) the true *M. alexandrinus*, found in Cashmere, and the whole north-west region of India; (2) the form confined to the Nepalese district, here termed *var. nitidus*, Hodgs.; and (3) the well-known *M. rufescens*, Gr., found in the whole of continental India except the north-western part, and also in Burmah.

The following is the Indian synonym of this species and its two varieties; but it is very possible that some of the names are put under the wrong varieties as these are not very sharply separated from each other.

MUS ALEXANDRINUS.

a. Typical variety.

M. asiaticus.
M. arboreus.
M. crassipes.

b. *Var. nitidus.*

M. nitidus.
M. pectoris.
M. rattoides.
M. horeites.
M. æquicaudalis.

c. *Var. rufescens.*

M. indicus.
M. flavescens.
M. decumanoides.
M. brunneusculus.
M. nemoralis.
M. kandianus.
M. ceylonus.
M. robustulus.
M. infralineatus.

Varietal Characters—Typical variety.—Dark rufous-grey above, white below. Size large, over 6 inches; tail much longer than the head and body, more noticeably paler below than in the other varieties. Soles of feet nearly always white (in spirit).

Variety *nitidus*.—Fur finer and rather more rufous, often mixed with numerous spines. Belly sometimes pure sharply-defined white, sometimes almost as dark as the upper side, the tips of the hairs, however, being nearly always white. Size about the same as in typical *alexandrinus*. Tail generally only a little longer than one inch; the head and body, seldom exceeding them by more than one inch; stretched skins therefore often have the tail even shorter than the trunk. Soles of feet often quite black.

Variety *rufescens*.—Body small and slender, only just over 5 inches in length. Tail much longer than the head and body. Colour dull rufous generally, but little paler below; fur coarse and spinous. This variety is much more arboreal than the others.

I can find no differences whatever between the skulls of these three varieties. Their general characters are too well known to need any detailed description; the dimensions of a specimen of *var. rufescens* will be found below under *Mus blanfordi*. The remarkable variation in the length of the nasal bones presented by this species is referred to below.

TABLE OF MEASUREMENTS.

	VAR. ALEXANDRINUS.		VAR. NITIDUS.	VAR. RUFESCENS.	
	Cashmere	Muscat	Darjeeling.	Madras.	Ceylon.
Head and body	6.1 6.3	6.8	6.1 6.45 5.8	5.5	5.2
Tail	7.1 7.3	9.3	7.3 6.7 6.2	6.7	7.65
Hind foot	1.4 1.25	1.29	1.45 1.4 1.2	1.45	1.22
Forearm & hand	1.66 1.50	1.64	1.3 1.7 1.5	1.67	1.45
Ear-conch, length	.68 .71	.85	.76 8.7 1.7	7.1	.70
Muzzle to year	1.44 1.49	1.55	1.72 1.56 1.38	1.4	1.31

These varieties seem to grade insensibly into one another. The rats of Cashmere and the neighbouring region agree perfectly with Egyptian specimens of *M. alexandrinus*; then, proceeding southwards, we find their fur becoming rather coarser and more rufous, and the animals becoming smaller, though presenting still much the same proportions. On the other hand, as we go from Cashmere to Nepal we find every immediate stage between the true *M. alexandrinus* and the fine-haired, comparatively short-tailed, *var. nitidus*. We must therefore consider them all to be of but one species, especially as we often find specimens which, without a knowledge of locality, it would be quite impossible to assign with certainty to any one of these three different forms.

With regard to the name adopted for the South-Indian variety, Mr. Blanford has kindly examined for me the types of *Mus indicus*, Geoffr., in the Paris Museum, and tells me that they are most certainly specimens of the rat generally known as *M. rufescens*, Gr.; and as their locality (Pondicherry) is a place where *M. rufescens* would naturally be found, I think there can be no doubt whatever as to the correctness of Mr. Blanford's opinion. As, however, the name *M. indicus* has been previously used by Bechstein, the later name *M. rufescens* must still stand for the common rat of the peninsula of India. The types of both *M. indicus* and *M. rufescens* have been much stretched, so as to have given rise to the erroneous statement in each case "Tail shorter than the head and body."

I have not space to discuss the various synonyms given above; but it will be seen that we have the types of a great number of these so-called species; and those of Hodgson's names to which I have not prefixed an asterisk merely represent forms of which we really possess the typical specimens among our series, but, as they are not specially marked as such, I am unable to lay my hand upon them.

I have, with some doubt, placed *M. infralineatus* under *var. rufescens*, as the colour characters given are quite unimportant, and the proportions might be those of an overstretched half-grown individual; it is, however, very possible that I may be wrong and that it is a distinct species.

Sir Walter Elliot informs me that this species seems to be gradually giving way before the more powerful *M. decumanus* which has been introduced into the various Indian ports from the shipping, just as in Europe the same ubiquitous species has nearly exterminated the corresponding northern form *Mus rattus*.

With regard to the specific distinctness of *Mus alexandrinus* from *M. rattus*, about which so much has been written, it seems to me that we have here a somewhat parallel case to that of *M. urbanus* and *M. musculus*. *M. alexandrinus* would seem to be a more tropical form of *M. rattus*, but as it seems always to have much shorter, coarser, and more rufous hair, as compared with the black and shining fur of *M. rattus*, I have provisionally kept them distinct, though I have but little doubt that they will have finally to be considered as but one species. This, however, is a question not specially Indian; and so at present I prefer to avoid expressing any definite opinion on the subject.

7. *Mus flavescens*.

Mus kandianus.

Mus cinnamomeus.

Hab. Nepal and Sikhim; Pegu (Berdmore).

Fur soft and fine, generally spineless, but with sometimes a considerable number of spines intermixed. Colour bright rufous above, with slate-coloured bases to the hairs; belly white, generally quite pure, but sometimes either mixed with slate colour or with a fulvous-grey stripe down its centre. Tail long, brown above, and but slightly paler beneath, sometimes with a tendency to the development of a pencil of hairs at the tip. I have not been able to find out the number of mammae present in this species. The skull, as in *Mus jerdoni*, differs from that of *M. alexandrinus* by the absence of the projecting angle in the front of the exterior wall of the infraorbital foramen, by the more open lower part of the same foramen, by its smaller teeth and shorter anterior palatine foramina. The difference in the zygoma-root will be better understood by a comparison of the figures of the two forms (Plate L, Fig. 3a and b) (not reproduced).

MUS JERDONI.

Leggada jerdoni.

Mus octomammis.

Hab. Sikhim; Khasya Hills, Assam (Blanford); Java (v. Hugel).

Fur long, fine, usually with numerous spines intermixed. Above the general colour is bright rufous, the hairs being dark slate-colour for four-fifths of their length, and the tips being orange-red; on the centre of the back there are numerous wholly black hairs mixed with the others; these thin out towards the sides, so that there the rufous colour is much clearer. Spines white, with black tips. Belly pure white, the line of separation well defined. Feet white as a rule, though sometimes the dark colour of the upperside runs down as far as the base of the digits. Tail very long, generally two and sometimes three inches longer than the head and body, brown above and white beneath from root to tip. Mammae eight, two pectoral and two inguinal pairs. Hind foot-pads (Plate L. I, Fig. 1) (not reproduced) six, large, nearly circular except the last, the terminal pad of the hallux very large. Ears rather large, oval; laid forward they reach quite to the eye.

Mus jerdoni seems to be almost entirely a highland species. Those I have seen have come from Darjeeling (7,000 ft.), Khasya Hills (4,000—5,000 ft.) and Willis Mt., Java (3,000 ft.). Jerdon mentions specimens from Kunawar (12,000 ft.); but, from the locality, I am inclined to think that they may have been *M. nivelventer*. Dr. Anderson tells me that these Kunawar specimens are not now in the Calcutta Museum; so that the question or the western distribution of this species cannot be settled at present.

MUS NIVELVENTER

Hab. The region bordering the Himalayas, from Simla to Katmandu; Darjeeling (Jerdon).

Fur rather coarse and short, sometimes thickly mixed with flattened spines, sometimes almost entirely without them. General colour above grey, with a tinge of yellow. Hairs dark slate-colour for nine-tenths of their length;

the tip in some yellow, in others black. The black-tipped hairs, which seem to be the coarser of the two, are more numerous in the centre of the back, so that that part is darker than the sides. Spines, when present, white, with black tips. Belly hairs and spines pure white to their roots, the line of demarcation sharply defined. Tail rather longer than the head and body, sharply bicolor, grey, above and white beneath; hairs on its distal quarter slightly elongated.

MUS BLANFORDI.

Hab., Kadapa, Madras (Beddom).

Fur long and soft, above slate-coloured for seven-eighths of its length, the terminal eighth being greyish fawn. The greater part of the belly is pure white in both specimens; but it is probably sometimes dark, as there is an indication of this colour on the centre of the chest in each case, as in certain specimens of *M. alexandrinus*. The tail is very much longer than the head and body; for half its length it is above and below dark-coloured and short-haired, as in other rats; but then its colour abruptly changes to white all round, and the hairs gradually lengthen from this point, and form a white brush at the tip. Dr. Scully's Gilgit specimens of *M. alexandrinus* have their tails much more hairy than is usual in that species; but in their other characters they in no way resemble *Mus blanfordi*.

The feet are entirely white in the adult male; but in the female there is a distinct brown tinge on the upper surface of both fore and hind feet; this, therefore, is no doubt variable.

The hind foot (Plate L.I., Fig. 6), not reproduced) is of somewhat different proportions from these which obtain in the other Indian rats, the tarsus being somewhat long, while the phalanges are particularly short. The proportional lengths of the toes are much as in *Mus alexandrinus*, except in the case of the fifth digit on both fore and hind feet, which is rather longer as compared with the fourth. The pads are large and rounded, and in the hind feet, somewhat crowded as shown in the figure.

The ears are large and dark-coloured. On their outer side the anterior half is thickly covered with short brown hairs, the posterior half being very nearly naked. On the inner side the hairs are much fewer and shorter than on the outer, and are mostly confined to the posterior half. In the original description the ears were said to be "nearly naked," but this condition in the type was probably owing to the rubbing the ears had received in the taking-out of the skull.

As far as I can discover, there are only six mammae in the female, one pair almost in the axillæ, and two pairs close together in the inguinal region.

TREATMENT OF LEPROSY IN THE PURULIA LEPROSY ASYLUM, BY ROST'S LEPROLIN.

BY J. FLEMING,

CAPTAIN, I.S.M.D.,

Civil Surgeon, Purulia.

AS the drowning man catcheth at a straw, so here in Purulia, the announcement by Captain Rost, in the May number, of Leprolin as the cure for leprosy, was caught at. Hope thus raised, and the inducement offered by Captain Rost that he would send samples free, at once encouraged me to send for a supply. With the consent of the Superintendent, five cases were selected representing at least three degrees of the disease from the Leprosy Asylum, and on the 4th of June the experiment was started. The abstract of