

themselves, since the kakapo is practically extinct in the North Island, while the Maoris are almost equally scarce in the kakapo districts of the South.

To return to Mr. Park's article, I must add that if the writer had been at all well acquainted with the habits of the kakapo he would at once have suspected who was his nightly visitant. Besides the fact that there are so few birds of any size in our New Zealand bush that confusion on the subject is all the more inexcusable, Mr. Park's description of the mysterious bird's behaviour at the camp-fire is the common experience of every one accustomed to camping in bush where the kakapo is plentiful. I have often, when camped out on the West Coast mountains, been obliged to tie the dogs up all night to save these birds, while visiting our fires, from being uselessly killed. Again, the incident of the unknown bird having been dusting itself in a "shallow hole in the sand" should at once have suggested the real truth of the matter to any West Coast bushman. This is one of the common habits of the kakapo, and these dusting-holes are often the first signs of the presence of these birds in the bush. Then, the nature of the country, and the time of day—or night—in which Mr. Park's adventures occurred, are exactly suited to the habits of the kakapo.

But perhaps I need say no more. Some may object that I have already paid more attention to this article than it deserves. But, however harmless at present, in years to come, when most of our native birds are extinct, and when it is therefore too late to disprove Mr. Park's conclusions, these confident assertions might seriously mislead future students of such subjects. To me it seems a grave misfortune that such a careless, erroneous, and illogical paper should ever have attained to such a position of importance and permanence as is assured by its being admitted into what is generally supposed to be a scientific publication.

ART. XXXIV.—*On the Habits of the New Zealand Bush-rat*
(*Mus maorium*).

By JOSHUA RUTLAND.

Communicated by Professor Hutton.

[*Read before the Philosophical Institute of Canterbury, 2nd May, 1889.*]

THE countless swarms of rats that periodically make their appearance in the bush country of the South Island, though casually noticed by the settlers ever since the founding of the colony, have not until recently attracted the attention of

accurate observers; consequently data are not now procurable from which a satisfactory conclusion may be arrived at as to the cause of this curious phenomenon.

Having witnessed two of these swarms, and carefully collected evidence from various sources, I now give the results, hoping that they may be found useful whenever this chapter in our natural history shall be more completely written.

Prior to the clearing of the land on which the city of Nelson now stands, one (or more) of these rat-swarms was there observed by the early settlers. In 1856 the district of Collingwood, on the western side of Blind Bay, was visited by a swarm; and, in 1863, I am informed of a swarm on the Shotover, Otago. But it is from the town of Picton that I have collected the best information. There, repeated swarms have been observed by the old residents. Unfortunately, I have been unable to ascertain the dates of occurrence excepting in four instances—namely, 1872, 1880, 1884, and the present spring (1888). From these dates it would appear that periods of about four years intervened between the swarms. Though I cannot discover that any had taken place in Picton during the eight years between 1872 and 1880, this may be accounted for by the fact that the swarms are not always generally diffused, but sometimes miss certain localities. Thus, in the Pelorus Valley, during the twenty-four years preceding 1884 these rats in any great numbers were not observed, though I am satisfied that previously swarms had here occurred, for shortly after my settling here in 1860 I was informed by the Maoris that during certain seasons immense numbers of rats made their appearance, destroying the crops—or, as they put it, “cutting the corn down all the same as with a sickle.” In like manner, in 1884, while Picton and the surrounding district were swarmed with rats, at The Rocks, on the opposite side of Queen Charlotte Sound, none, or very few, made their appearance, though I am informed that during a previous swarm this locality was visited like other places.

These rat-swarms invariably take place during spring. In August a few of the little animals appear; as the weather grows warmer they gradually increase in number until November, when all disappear again gradually, as they came.

While in a locality dead rats are seen lying about in all directions—on roads, in gardens, and elsewhere. Very few have any marks of violence on their bodies; nor can it be supposed that they have died of hunger, since on examination they are generally found fat. In Picton, during the swarm of 1884, the stench becoming unbearable in one of the houses, the floor of the sitting-room was removed, when forty-seven

rats were found lying together dead near the fireplace. In another house on the opposite side of the same street thirty-seven were found under the floor of the kitchen. Indeed, the whole town was pervaded with the odour of dead rats. It took the place of pastille in the drawing-rooms, and overpowered that of sanctity, even, in the churches.

In size and general appearance the bush-rat differs much from the common brown rat. The average weight of full-grown specimens is about 2oz. The fur on the upper portions of the body is dark-brown, inclining to black; on the lower portions white or greyish-white. The head is shorter, the snout not so sharp, and the countenance milder, or less fierce, than in the brown species. In 1884 and during the present year numbers of these animals were to be seen with their tails more or less mutilated and diseased.

On the open ground the bush-rat moves comparatively slowly, evidently finding much difficulty in surmounting clods and other impedimenta; hence they are easily taken and destroyed. In running they do not arch the back as much as the brown rat. This awkwardness on the ground is at once exchanged for extreme activity when climbing trees. These they ascend with the nimbleness of flies, running out to the very extremities of the branches with amazing quickness; hence, when pursued they invariably make to trees if any are within reach. The instinct which impels them to seek safety by leaving the ground was curiously illustrated here this season: a rat, on being disturbed by a plough, ran for awhile before the moving implement, and then up the horse-reins, which were dragging along the ground. Another peculiarity of these animals is that when suddenly startled or pursued they cry out with fear, thus betraying their whereabouts, an indiscretion of which the common rat is never guilty.

While the rats were about the Pelorus Valley in 1884, and again in the present year, many nests were found evidently constructed by them. These nests, which are built of fine grass, leaves, and other soft materials, are placed under the roots of trees, amongst rushes, and not infrequently in the crowns of tree-ferns; but for what purpose they are intended I do not know—as far as I have been able to ascertain, young ones have never been found in them.

The extremely few females that occur amongst the countless hordes is a fact that shows that if breeding does take place at all during these periods it must be on a very limited scale.

Besides these nests there are to be found, lying on the ground in the shade of the bush, the hollow trunks of fern-trees containing quantities of the stones of the hinau fruit, each stone having a small hole pierced in the side, through

which the kernel has been abstracted. This is the work of the bush-rats, but I am not inclined to think that it is all done during the periods of swarming above referred to.

Considering the vast numbers of these rats that periodically congregate round the homes of settlers in the bush, the mischief done by them is extremely small. This is owing to their food during the time being green vegetables. In kitchen-gardens they are certainly annoying, devouring peas, beans, cabbages, and even onions, as they appear above ground, climbing hop-poles to nip off the shoots of the vines, and making a clean sweep of the strawberry-crop long before the fruit is ripe. Though they enter dwelling-houses and barns, it is evidently not in quest of food, as shown by corn and other eatables being left untouched by them.

When lately making inquiries whether these rats were on the new Mahakipawa Goldfield, I was told they were there in thousands, running over everything; "but," added my informant, "they are harmless—they don't interfere with the flour-bags."

Such are briefly the results of my observations and inquiries concerning the habits of the bush-rats. I will now examine the various reasons that have been assigned for their periodical appearance, commencing with that given by the Maoris—namely, the failure of the kiekie fruit, causing these animals to leave the hills and seek other food. Any one acquainted with the distribution of the kiekie (*Freycinetia banksii*) in this portion of the island will at once perceive the insufficiency of this cause. Though the kiekie covers considerable areas on the hillsides and on the shores of the Sound, it is either entirely absent from the inland valleys or only occurs in patches along the sunny sides high on the hills, where it rarely flowers. I have no doubt that the kiekie fruit would be very acceptable to the bush-rats, but it can never be in sufficient quantity to form an article of food on which they would be dependent. Besides, their appearance in places where the kiekie does not occur as well as where it is plentiful points clearly to some other cause. I shall have, however, to return to this later on.

During the winter months preceding the swarm of 1884 heavy falls of snow took place throughout this district, covering the higher portions of the hills. The mixed bush of the low lands also bore a plentiful crop of fruit the previous summer. To both of these circumstances the appearance of the rats was attributed, some averring that they had been driven down from the hills by the snow, others that they had been induced to come down by the large supply of food on the low land.

I particularly noticed the recurrence of the two conditions in 1887—an abundant crop of fruit throughout the mixed bush,

followed in season by heavy falls of snow on the surrounding hills: but no swarm of rats visited the locality in the succeeding spring: whereas this year, after an unusually mild winter—sufficient snow to whiten our hill-tops not having once fallen—and the crop of fruit on the low lands being very moderate, the rats have made their appearance precisely as they did in 1884.

The most generally-received explanation of the periodical appearance of the bush-rats in the northern portions of this island is that they migrate hither from a more southerly district. Hearing that Kaikoura is supposed to be their place of departure, I made particular inquiries, and find that the animal is unknown there—at least, on the seaward side of the range.

Putting aside the question from exactly whence these rats come, I will take one of the natural subdivisions of the County of Sounds, and examine what takes place there during the periods of swarming, and how far it coincides with the migratory theory.

The curiously irregular block of land that divides the waters of the Pelorus and Queen Charlotte Sounds, and in which Mount Stokes forms a prominent feature, contains numerous small valleys or groups of valleys, separated from each other by rugged wooded ranges rarely less than 1,000ft. in elevation. The only connection this district has with the mainland is the long, narrow mountain-ridge that forms the southern shores of the Kenepuru Reach. Where the public road crosses this ridge, from the head of Torea Bay, in Queen Charlotte Sound, to Portage Bay, in Kenepuru, is a low saddle about 400ft. high, the distance between the two waters being only about 40 chains. The land here is mostly in grass, and is occupied by a settler's family. During the spring of 1884, while the bush-rats were so numerous in Picton, and in the Pelorus, Kaituna, and other inland valleys, they were equally numerous in the valleys round Mount Stokes before mentioned. Now, supposing the migratory theory to be correct, the whole of the vast throng of animals must have found their way thither over the narrow neck of land between Portage and Torea Bays, must have crossed the public road, and must have passed the homes of the people there settled; but no such movement was by any one observed. Indeed, one fact which I carefully verified this spring seems to me irreconcilable with the migratory theory. It is the simultaneous appearance of the rats in this isolated portion of the County of Sounds and in certain inland valleys to the south.

Early last August, noticing that the rats were coming about the low land on the north bank of the Pelorus River, and having occasion at the time to visit Kenepuru, I made

inquiries immediately on my arrival, and obtained positive evidence that the rats commenced making their appearance there at the same time as they did in the Pelorus. Considering the geographical position of the two localities, I can hardly see how this could take place if the animals came from the more southerly portions of the Island. During the three months the rats remain on the low lands of the bush country they certainly have no appearance of travelling in any particular direction, but merely wander about like animals in quest of food.

In the early part of November, while the rats were so numerous in the Pelorus Valley, one was observed evening after evening for about three weeks coming out from among the flowers in my garden, climbing a rose-tree that grows against the verandah-post, and making his way along the wall-plate to the roof of the building. This took place with such regularity as to leave no doubt of its being the same individual. I mention this as it plainly shows that these animals are not always mere passers-by.

It may now be very reasonably asked, What, then, is the cause of the periodical appearance of the bush-rats?

To this question I shall not attempt any definite reply, as I do not consider the information at my command sufficient to warrant my so doing. There are, however, certain circumstances which seem to suggest a solution of the problem; and to these I shall now refer. Generally, if not always, accompanying these rat-swarms are large flocks of parroquets. On the outskirts of the bush, as in Picton, the Tuamarina, &c., these birds make their appearance a month or so later than the rats; but within the bush country they appear simultaneously, or, if there is any difference in the dates of arrival, the parroquets are first noticed. Although the parroquets only appear here periodically in large numbers, the bush is never without them, and this remark is equally applicable to the bush-rats; though, owing to their habits and being less conspicuous, they are not so generally observed. Every spring a few of these little animals may be seen on the open tracts within the bush country, and even during the twenty years wherein no swarm took place in the Pelorus Valley they were frequently observed, but not in sufficient numbers to attract much attention.

Another instance of the appearance in large numbers of animals generally scarce is furnished by the mosquitoes of the Pelorus Valley. A few of these troublesome insects are invariably found here throughout the warm season. Every now and then immense swarms appear. These swarms, which occur sometimes in spring, sometimes in autumn, are undoubtedly due to the occurrence of conditions favourable for

their increase; and it seems to me that it is in the working of this same law that an explanation of the periodical appearance of both the rats and parroquets will be found.

During the summer and autumn preceding the great swarm of 1884, while moving about various portions of the bush country, I noticed that the nests of parroquets were unusually numerous. Everywhere I went people had the unfortunate young birds confined in cages, for what they grimly termed "pets." A similar abundance of nests was again observed last year, preceding the swarms of parroquets and rats which have just taken place.

A supply of food being the most important of the conditions necessary to the increase of the higher or viviparous animals, and the rats being herbivorous, we naturally turn to the productions of our forests when seeking an explanation of their periodical appearance on the above-mentioned basis. Here we are at once confronted with the facts that the swarms of 1884 and of the present year followed after heavy crops of fruit throughout our beech-forests, and that such exceptional crops are produced at intervals, both by the more homogeneous beech-forest and the mixed bush of the low lands, though they are not always coincident. That the upper portions of our hills, which are mostly clothed with the various species of beech, are the proper habitat of the bush-rat, I think there can be little doubt. One hill in this district bears the name of Kaikiore, the tradition connected therewith being that some natives, while hiding from their enemies, subsisted on rats, which they found in great numbers; and this, again, I think, accounts for the statements made by the Maoris that the appearance of these rats on the low lands is due to their being compelled to leave the hills through the failure of the kiekie fruit; for, though I consider the cause insufficient, it must often be coincident with the period of swarm.

While venturing the above suggestions, I clearly perceive that no explanation can be deemed satisfactory that leaves the enormous preponderance of males in these rat-swarms unaccounted for. Amongst English country-people, who have the best opportunity of observing them, it is commonly asserted that in litters of young rats the males produced outnumber the females by about seven to one. Whether this is correct, or, if correct, whether it holds good of all the species of the genus *Mus*, I do not know; but, even if it is the fact, it would be insufficient to account for the disproportion of the sexes found in our rat-swarms.

Two questions here present themselves: (1.) Would a sudden increase of numbers, consequent on an excessive food-supply, affect the usual proportion of the sexes? In the case of the hive-bee, whether a nymph shall develop into a barren

worker or a fertile queen is determined by the food given. (2.) Is the preponderance of males due to a separation of the sexes through these animals having to extend their range in quest of food? To these questions further observation can alone furnish replies.

NOTE BY PROFESSOR HUTTON.

Measurements.—The Maori rat is smaller than either of the other two rats found in New Zealand, and the female is rather smaller than the male. The following are measurements of three individuals of each sex, given in inches:—

	♂	♂	♂	♀	♀	♀
Snout to root of tail ..	4.85	4.6	4.5	4.8	4.7	4.5
Length of tail	4.85	5.4	5.5	4.5	4.6	4.6
Total length	9.7	10.0	10.0	9.3	9.3	9.1

The difference is thus seen to depend on the length of the tail, which is shorter in the female than in the male.

The other dimensions are: Length of head, 1.5in.; breadth of head between the ears, 0.6in.; length of ear, 0.6in.; breadth, 0.45in.; length from nose to ear, 1.3in.; length of hind foot 1in., of fore foot 0.5in., inclusive of claws. All the toes have claws.

Colours.—In colour they much resemble the common brown rat. The upper surface of the head and body is brown, finely mottled with dark-grey. This is due to the hairs, some of which are nearly black, but most are dark-grey at the base, broadly tipped with reddish-brown. The sides of the body are lighter, and all the under-parts, including the chin and feet, are dirty-white. The fur is slate-blue. The tail is scaly and sparsely covered with short hairs, which are black on the upper surface and grey on the lower. Ears rather large and rounded at the tip, yellowish-brown, with minute grey hairs on both surfaces. Hairs of moustache, most black, some white; length, 1.75in. Upper incisors orange, lower yellow. Legs and feet yellow, with short white hairs; the hind feet with small tufts at the end, projecting over the nails.

In 1884 Mr. Rutland sent me four heads of this rat. Two are coloured as described above, but the other two are lighter in colour and redder. One has brownish-red hairs on the cheeks only, the rest being reddish-brown; but the other is entirely brownish-red, quite foxy in colour over the upper surface of the head and neck. This may be a distinct species.