

# Notes on the Hawaiian Rat.

BY JOHN F. G. STOKES.

IN the preceding paper Dr. Stone has undertaken to give the writer more credit for his observations than is his due, such observations being mostly the result of accidental findings in the prosecution of his regular work; and has further done him the honor of inviting him to add his name as co-author, which it seemed to him more fitting to decline, since his work is outside the field of systematic zoology.

We much appreciate Dr. Stone's kindness in looking into the subject of the native rat and describing the specimens, especially as there is no mammalogist on the Museum's staff.

The following notes may be added to those already communicated and may be of service in throwing more light on the habits of the native rat. They include observations made since the despatch of the original rat material to Dr. Stone, and references to the rat in the life of the Hawaiian people.

On the island of Kauai, in 1916, the Weliweli and Mahaulepu sand-dunes, in the neighborhood of some petroglyphs the writer was measuring, were visited. Some little time was spent on the Weliweli dunes gathering fossil land shells, and incidentally a fairly thorough but unsuccessful search for rat bones was made. On the Mahaulepu dunes, three miles to the north, the visit was briefer and the search confined to ethnological material and fossil shells, since the Weliweli dunes had yielded no rat remains. A few samples of sand containing the fossil shells from Mahaulepu were brought back to Honolulu, and when Dr. C. M. Cooke sifted the same, he found a small mammal bone comparable in size to the rat bones from Heleloa and Kahoolawe. Being a mammal bone, its size would indicate that it probably belonged to the native rat species.

The same year remains of rats were found at three places in the Wailuku sand-dunes, Maui. These dunes, used as pastures, extend about five miles to the northeast and southwest of the Iao stream's stony bed. The stream, a mountain torrent subject to heavy floods, has swung back and forth, during its existence, over



a breadth of a quarter of a mile. The resultant stretch of volcanic rocks and soil divides the two series of dunes. The present trend of Iao is westward, and it is now undermining the dunes on that side, leaving a high bank of dry, rolling sand. The eastern series of dunes is now well covered with fodder trees (*Prosopis juliflora*), but on the dry, western series the vegetation is merely a thin growth of dune grasses and weeds; its upper strata are changing into æolian sandstone.

Crowning two of the high dunes of the latter series, and about three hundred feet apart are the foundations of the old temples Pihana and Halekii. The foundations are loose, dry-laid, water-worn stones, piled up over a century ago by the Hawaiians. Such stones are seldom seen on the dunes, and when found there, their presence is traceable to human agency. Generally near them are stunted lantana shrubs. The Pihana and Halekii dunes are more or less isolated from the surrounding volcanic soil and rocks by other sand-hills or bare sandy slopes; Halekii more so than Pihana.

The rat specimens first noted here were a few scattered leg bones among the remains of the offerings—human, pig, dog and fish bones, shells, etc., on the surface at Pihana. Offerings at temples ceased a century ago, and the large mammal bones were almost completely destroyed by weathering. The rat bones were in a good state of preservation, and unless they had been recently uncovered by the sand shifting, they post-dated the other bones. They were from mature animals, and probably the native rat. Half of Pihana's foundations had slid down the steep bank which the stream had undermined, and the offerings were found on the remaining portion of the stone floor and on the sliding sand.

Halekii temple had not been disturbed by the stream and was five hundred feet distant from it. A recently dead rat was found there exposed to the weather on one of the foundation stones. It had been dead probably less than ten days, as the eyes were present in position. Decomposition of the soft body parts was complete, and the flesh of the legs and tail had dried. There was still a marked odor. The fur was present, except on the right side, on which the animal was lying. The writer has little hesitation in identifying the specimen as a native rat, from the color of the fur and the size of the animal.



This specimen and the rat bones above mentioned were forwarded to Dr. Stone, but crossed his MS. in the mails.

In the eastern dune series, on the site of the old battle field of Kakanilua, two miles from Halekii, half a mandible and two leg bones of what may reasonably be referred to the native rat, were later picked from the surface of the sand.

The presence of the living rats on Popoia (reported to Dr. Stone) suggested a search on other islets. There is a small mushroom-shaped islet called Kekepa on the coral reef at the eastern entrance to Kaneohe Bay (see map, Plate X). Its area is about an acre, and the highest point of its surface is fifteen to eighteen feet above mean tide. On account of its situation a landing can only be made on the narrow wave-washed shelf encircling its base, at low tide and in calm weather. The writer visited Kekepa in 1915. It was of raised coral reef formation; its surface was honey-combed, and the same species of petrels were nesting as at Popoia. Vegetation was confined to shore plants; there were no shrubs or trees. Though the writer, when starting, prepared himself with traps, he could not use them since the boatman, on reaching Kekepa, limited the stay to fifteen minutes on account of the rising sea. Enough was seen of conditions at Kekepa, however, to suggest the probability of the rat being present.

Another reason for the visit was curiosity aroused by the account of a young native boy that his parents had seen on the islet a small brown bird of the size of the imported mina (*Acridotheres tristis*) which jumped instead of flying. The parents were absent, and the information above was furnished in reply to a casual enquiry of what was to be seen on Kekepa, which was in sight in the distance. Of course, the description of the bird would fit one of the extinct Hawaiian rails (*Pennula* sp.) better than any other known Hawaiian birds, and considering the honey-combed condition of the surface of Kekepa, the writer would not care to state that the rail was not on the islet.

On the volcanic island of Mokulua North a fairly thorough search was made among the rocks near the sea, and in likely places a little further back, without finding indications of rats. A less thorough search at Mokulua South gave no better results. These islands are high and were probably formed independently from Oahu.



Summarizing the results concerning native species from all the localities visited and mentioned in this and Dr. Stone's article preceding, we get, if the writer's identification of the material be correct, on the islands of—

## Kauai:

|                        |                    |
|------------------------|--------------------|
| Sand-dunes, Weliweli.  | No traces of rats. |
| Sand-dunes, Mahaulepu. | Skeletal material. |

## Oahu:

|                                     |                                                |
|-------------------------------------|------------------------------------------------|
| Reef islet of Popoia.               | Living rats.                                   |
| Reef islet of Kekepa.               | Natural conditions for rats similar to Popoia. |
| Volcanic coastal islets of Mokulua. | No traces of rats.                             |
| Sand-dunes, Heleloa.                | Skeletal material and possibly living rats.    |

## Maui:

|                      |                              |
|----------------------|------------------------------|
| Sand-dunes, Wailuku. | Skeletal and fresh material. |
|----------------------|------------------------------|

## Kahoolawe:

|                  |                                             |
|------------------|---------------------------------------------|
| On barren coast. | Skeletal material, with introduced species. |
|------------------|---------------------------------------------|

Except for Kahoolawe, these observations cover a period of less than two years. Only at Popoia and Kahoolawe was there any amount of time spent. When we consider that the results obtained were mostly due to accidental discoveries through brief visits made only as time permitted, the conclusion seems obvious that the Hawaiian rat may yet be found alive in many other localities which it may have reached, where conditions are favorable for its preservation.

In seeking for these favorable conditions, we would ordinarily select localities from which the native rodent's introduced competitors or natural enemies (large rats and mongoose) are debarred by natural conditions; which do not furnish sufficient food or cover to attract them; or to which they have not so far extended. This much has apparently been found in the shore-lying islets and coastal sand-dunes, which are common in this group. Among the former, for instance, on Oahu (see map) may be Kekepa (raised reef) and Mokolii (volcanic). Other islands, Kapapa (raised reef) and Mokumanu, Mokulua, and Manana (all volcanic) may be too distant. Moku o Loe (volcanic), in Kaneohe Bay, should be a good locality, and it is reported as being overrun with rats of a species not known at present. This island was recently inhabited, and is so frequently and easily visited that the rat may well prove to be of an introduced species.

The sand-dunes, used for cattle grazing, are generally covered with a sparse herbal growth, sufficient perhaps to support the



smaller native rat, yet not enough to attract the larger introduced animals from the richer pastures around the human dwellings or in the sugar-cane fields inland. On the dunes the mongoose is a rare visitor. Its nature is to stay close to cover, and a place bare of stones and without thick grass probably would not appeal as good hunting ground.

The writer would suggest that a study of conditions similar to those of the Hawaiian group, in the islands of the South and West Pacific, might demonstrate that the other species of Oceanian rats, now believed to be rare or extinct, are yet to be found alive.<sup>1</sup> It is a matter for zoologists to follow up if the suggestion be deemed worthy of consideration.

Some of the Popoian rats were kept alive in Honolulu, as reported to Dr. Stone. The intention was to breed them and distribute the progeny among some of the more distant small islets where they could work no harm and might be preserved from their introduced enemies. The record is herewith:—

## FIRST CAGE.

May 11, 1915. No. 0 ♂ and No. 9016 ♀ trapped, placed together.  
 June 11, 1915. No. 9040 ♀ added to pair. No. 0 ♂ and No. 9016 ♀ mated.  
 June 28, 1915. No. 9016 ♀ died in parturition.  
 June 28, 1916. No. 9040 ♀ died.  
 At date. No. 0 ♂ on hand, alive.

## SECOND CAGE.

Sept. 19, 1915. No. 9024 ♂ and No. 9017 ♀ trapped, placed together.  
 Sept. 22, 1915. No. 9017 ♀ died.  
 Nov. 29, 1915. No. 9024 ♂ died.

Observations on the habits of the rats have been conducted with difficulty on account of the extreme shyness of the animals. The cages were fastened just outside window sills so that the ani-

<sup>1</sup> Skeletal material might be found in old Polynesian temples. In the notes sent to Dr. Stone it was mentioned that the fishermen's religious offerings of food (fish, meat, fruit and vegetables) had served to sustain the Kahoolawe rats. The specimens found on the Wailuku ruins were, probably, all comparatively recent, but their presence calls to mind the indirect reference made by many writers, native and others, to rats in Hawaiian temples. There the rodents would find ample shelter among the loose stones, and live on the fat of the land. The food offerings were abundant and varied. "Poor as a church mouse" could not be said of the Hawaiian temple rat. In Tahiti particularly, where worship and offerings were very similar to the Hawaiian, a search might bring results which would aid materially in identifying Peale's *Mus exulans*.



imals could be watched from the room through the uncovered wire at the top. Their reaction to sound and scent was so sharp that they could detect the quiet approach of an observer before they could see him and would then remain motionless, except for their twitching snouts and ears, as long as a person cared to watch from a little distance. A nearer approach to the window would cause a scurry for the sleeping box. Subsequent observations would then be limited to the pair of twitching noses poking out of the box opening.

The appearance of a person above the cage always terrified them. Later, the cage was changed to a window where the rats were just above the level of one's head when standing on the ground. In this situation, one of the rats became tame enough to eat from (and of) the fingers. However, movement above the cage continued to frighten them as much as ever, and the upper part of the cage was subsequently covered over.

Noise of any kind disturbed them, particularly the sharp snapping of the cage wire when opening the little door, when they would freeze as though expecting to meet their doom. It is evident that any future observations should be conducted in a cage which can be handled noiselessly.

They are on the move during the whole day, and feed freely at this time. Judging from the noise, however, their greatest activity is in the early part of the night. Their long sleep must take place between 9 P.M and 8 A.M.

Their food has been bread, cooked meat, bones, fresh, salt and smoked fish, lettuce, sow-thistle, cabbage, wheat, oats, walnuts, apples or anything else in the house. The bones are not closely gnawed. Papaya (*Carica papaya*), a fruit of which the imported rats are very fond, destroying many on the trees, was refused by those under observation.<sup>1</sup> A leg of the common rock crab (*Grapsus* sp.) was also refused, though probably on account of the difficulty of breaking through the shell. They have been observed chasing the common wood-roach, which occasionally crawls into the cage, but the chase stopped as soon as the observer approached the cage from above and the roach escaped. Living sow-bugs and

<sup>1</sup>In January, 1917, papaya was fed to and eaten by the male which had been in captivity for twenty months. At this time also the milo seeds were first fed, to the same rat; they were not eaten very readily.



parts of centipedes were eaten readily, the harder portions being chewed for some time and then ejected. An immature mouse was once found in the cage with the head eaten.

Early in 1916, during the damp weather, the introduced snail (*Eulota similis*) was very plentiful. A few were fed by the writer's wife to the rats in the illustration (Pls. XIII, XIV); they ate them very readily, biting through and completely crushing the fragile shells with ease. The rodents sat on their haunches and held the snails with their fore paws. In less than an hour twenty-one snails were eaten, and the indications were that more would have been consumed had they been available. From this time on snails, when found, became a part of the rats' diet. One of the large introduced slugs (*Veronicella* sp.) was placed in the cage and the male rat made many attempts to bite it before it crawled out again.

The native arboreal and terrestrial mollusca in some of the local forests are suffering from the depredations of rats, according to present day collectors, undoubtedly the introduced species. Dr. Cooke states that, at times, scores of mutilated shells are found about the entrances to the burrows, the owners of which had apparently carried them there to eat at their leisure. On learning of the Hawaiian rats' appetite for the *Eulota*, two nearly mature living specimens of *Partulina redfieldii*, a native arboreal pulmonate, were placed in the rats' cage. The rodents attacked them only at the aperture, breaking off the outer lip and failing to reach the soft parts.

In Pl. XV, No. 2 is one of the shells so treated, placed for comparison beside a whole specimen (No. 1) of *Partulina redfieldii* of about the same size and in the same relative position. They are illustrated at the suggestion of Dr. Cooke, who has kindly mounted with them eight other specimens (Nos. 3-10) recently collected, from which the softer parts had been extracted by an introduced rat. No. 8 is harder than No. 2, and Nos. 5-7 nearly as hard.

It will be noticed that the attack by the introduced rat was generally directed at the last whorl, in which the larger part of the molluscan body lay. Of the nine specimens in the Museum's possession,<sup>1</sup> one, not illustrated, was also attacked at the aperture

<sup>1</sup> From the shell collection of Mr. Irwin Spalding.



lip. In one (No. 3) it will be observed the apex is gone. Popoian rats had always completely crushed the shells of the *Eulota*, so observations were made on the method of initial attack on this species by the remaining living native rat, ♂ No. 0. After feeding one snail at a time and then interrupting the meal, it was found on examining the shells that all were attacked at the last whorl, one of which was also broken at the aperture. In the latter instance, the body of the snail was expanded just before it was seized by the rat. From the above observations and illustrations, it might appear that the rats attack the portion of the shell where the molluscan body is found.

Many of the Hawaiian terrestrial mollusca are smaller and are provided with more fragile shells than those illustrated above, and may well have contributed to the diet of the native rat before it was displaced by the introduced species.

In the communications to Dr. Stone, reference was made to the inability or lack of desire on the part of the Popoian rats to escape by gnawing through the soft wooden lining of the cage. Evidence of the ability of the common house rats, or even mice, to gnaw through thick wood has been presented to most people who live in wooden houses. The Popoian rats, on the other hand, have made no attempt to gnaw their way out through the wood, though for the first two days of captivity they tried to bite through the exposed wire front. Bones and tough cartilage they do not seem to make an impression on, and they were unable to bite through the leg of our common rock crab, as already mentioned.

It would thus seem that there was a comparative weakness in the Hawaiian rat's gnawing system, due probably to undevelopment in the species. Such a probability could be explained if we were to take into consideration, for example, the conditions under which the house varieties of the different species operated. Foreign rats and mice have had, for very many of their generations, closely fitting wooden walls and floors to contend with, and innumerable enemies to compel them to keep close within the shelter of such wooden constructions. The Hawaiian rat shared the open life of its human neighbor, with few natural enemies except the same neighbor, and found the grass house walls, and loose stone foundations and floors, places for easy hiding.



When repacking the first rats caught on Popoia to mail to Philadelphia, a number of lice and mites were found in the original alcohol. Mr. O. H. Swezey examined them, and as our literature on the subject is very scanty, he has only tentatively determined the louse as *Polyplax* [*Haematopinus*] *spinulosa*: adults, young and eggs. Mr. J. C. Bridwell has recognized the mite as belonging to the *Gamasidæ*, and closely resembling but not identical with the poultry tick, *Dermanyssus gallinæ*.

Mr. T. G. Thrum, a lifetime student of Hawaiian legendary lore, has found in his readings many references to the native rat. In particular, an interesting account of the pastime of rat hunting is given in the legend of Pikoiaakaalala,<sup>1</sup> the infant prodigy with the bow and arrow. The legend, full of the marvelous, is appropriately referred to at this time on account of the mention of three kinds of places where the rat-killing contests occurred. One was a wilderness or deserted cultivation field on Kauai. The second, on the coastal plains of Oahu, covered with a lowland herbaceous form of the *aweoweo* (*Chenopodium sandwicheum*), among the stems and leaves of which the rats took shelter. The third was the king's grass dwelling house near the shore, where the rats were shot on the floor and the interior of the roof.

From the legend is also ascertained the mode of procedure in the contests. The first competitor shot continuously at such rats as were pointed out by his opponent to the number agreed upon. Then the latter took his turn and shot as ordered by the first. The total score, of course, determined the winner. From the same legend, it would appear that the chiefs had in their retinue, men or women employed as rat killers, and indulged in betting on the contestants' skill.

There is another account, that a place was cleared of brush and weeds, and the rats then driven into the clearing as marks for

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<sup>1</sup>S. M. Kauai, He Kaa no Pikoiaakaalala. Nupepa Kuokoa, Honolulu, Dek. 16, 1865-Mar. 18, 1866. This is not the best version, as Kauai missed the point of the legend, i. e., the opportunity of bringing in a play on words, where the youngster displayed his smartness. It was selected for this reference, however, because the places where the shooting was said to have occurred must have appeared so natural to a Hawaiian recounting the legend fifty years ago as to mislead him in his understanding of the intent of the tale. A better version, from among the Abraham Fornander MSS., will be published in the Museum Memoirs in the near future.



the archers. In the pastime the small extinct rail previously mentioned was sometimes substituted for the rat.

We have no record in the Hawaiian Group of any contrivance in the shape of a rat-trap such as occurs on some of the other Pacific islands. The bow and arrow was probably depended on to keep down the rats as vermin. As late as 1888, Mr. J. S. Emerson secured from a native, about ninety years of age, on the island of Hawaii, a small bow and arrow which was kept in the house for shooting "mice".<sup>1</sup> Mr. Emerson set up a mark about sixteen feet off, to test the old man's skill, and found him very proficient. The bow was not used in warfare.

The Hawaiians formerly had an outdoor rack for protecting food from dogs, hogs and rats. Sometimes it was a branched tree set up outside the house, from the branches of which the food bowls would be suspended in netted bags. In this museum are two carved wooden racks for the same purpose. They are canoe-shaped, notched on the upper edges, and were set across the ends of upright posts.<sup>2</sup>

One of the native superstitions concerning the rodent was that if the baby's umbilical cord (some authorities state, the boy's prepuce also) were eaten by a rat the child would grow up a liar and a thief.

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<sup>1</sup> Introduced, without doubt. One or two references to the probable existence of a native mouse, as well as a rat, have been met with, but on what grounds it was not stated. Cook and King (Cook's Third Voyage, London, 1785, Vol. II, p. 228, and Vol. III, p. 117 respectively) both state that there were only three mammals in the Hawaiian Islands, the dog, hog and rat, resembling those seen at every other island touched at. King spent several weeks ashore and had full opportunity for observing the mouse were it present. The Hawaiian term for the rat was *iole*, and the same term in its varying dialectic forms was found among other Polynesians with the identical application. The early Hawaiian biological nomenclature was very profuse and apparently exact as to variety. To quote two examples only, there were over sixty terms for varieties of taro; and three or four terms for the fish *ulua* in its different stages of growth, although all stages were recognized as belonging to the same fish. There is little question that had there been two native rodents the ancient Hawaiians would have used two different terms. As the old systems became obsolete through foreign influence, the Hawaiians seemed to lose their aptitude in "giving a thing a name." The introduced mouse was known as *iole liilii*, "little rat", and the wharf rat *iole nui*, "big rat", which term was also applied to the rabbit.

<sup>2</sup> B. P. B. Museum Memoirs, vol. ii, fig. 67, p. 205.



LATER NOTES.

Dr. Stone has identified the Wailuku temple rats as the same as the others.

On February 4, 1917, I met a native at Kailua who said that his grandfather claimed to have accidentally introduced the rats to Popoia, where, according to the statement, there were none before. The account is that the rats were transported from Kailua beach in the folds of a fish-net, and escaped when the net was spread out on Popoia. The claim that such an introduction took place is reasonable, and I am glad to be able to mention it in these notes. It would suggest the advisability of examining the sand-dunes before the shore islets when looking for the native rat. The introduction occurred "more than twenty years ago," which might mean, on account of the Hawaiians' difficulty in recalling dates, any time previous to such limit. At the present time introduced rats and mice are plentiful about the houses at Kailua beach.

Two Hawaiian rats were seen on Popoia on February 4, one in the open, and one among the milo trees; and on February 11 a young male was trapped at the latter place. It was active and seemed healthy, but died on March 1.

On February 25 and March 4, Dr. C. Montague Cooke found many native rat bones on undulating sand-plains and low dunes near the northern point of Oahu. They were in beds of fossil shells, which had been disturbed by road grading. The shell deposits are probably much older than the Heleloa dunes.



## EXPLANATION OF PLATES.

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### PLATE VIII.

*Rattus hawaiiensis*, type.

### PLATE IX.

Material from Kahoolawe; No. 9032, *Mus musculus*. Other rat material, *Rattus hawaiiensis*. Nos. 9027 and 9029 from young specimens.

### PLATE X.

Part of Oahu, showing location of Heleloa and Popoia.

### PLATE XI.

Popoia Islet.

South shore, showing erosion.

### PLATE XII.

Popoia Islet.

Upper figure. Shore pool showing erosion: looking outward.

Lower figure. Surface of northern part.

### PLATES XIII, XIV.

*Rattus hawaiiensis*, ♂ No. 0, ♀ No. 9040. Height of drinking cup is 68 mm.

### PLATE XV.

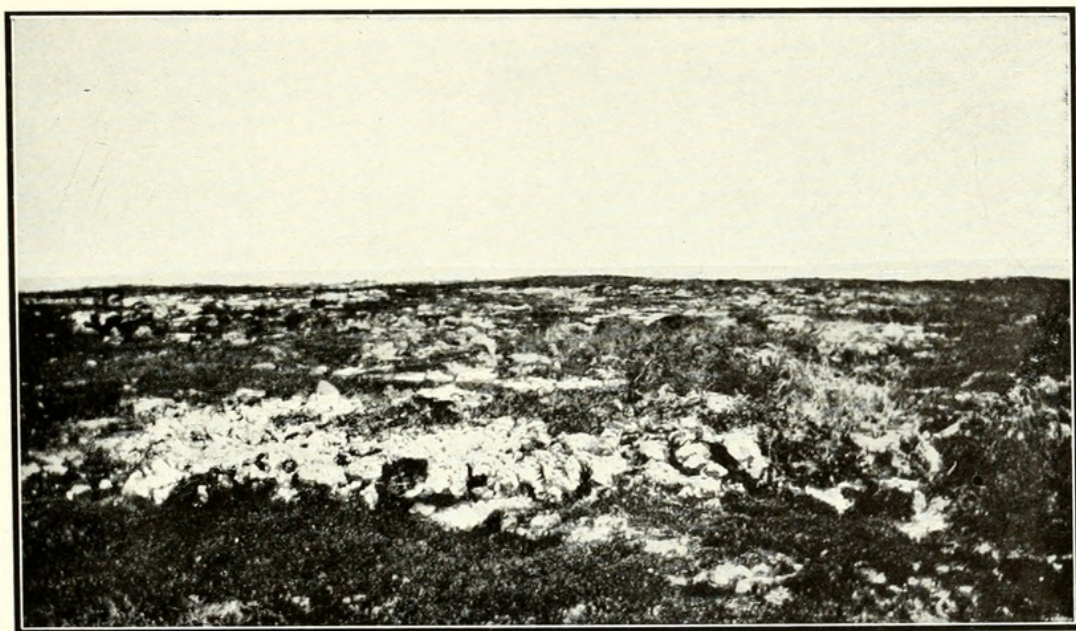
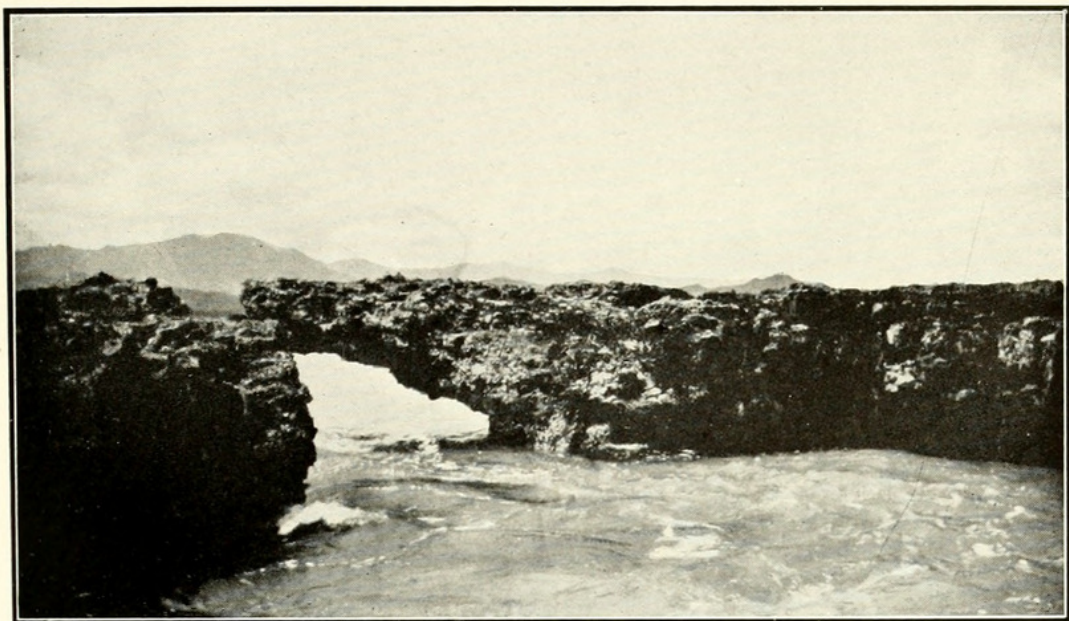
Hawaiian pulmonates attacked by rats. Explanation on plate.





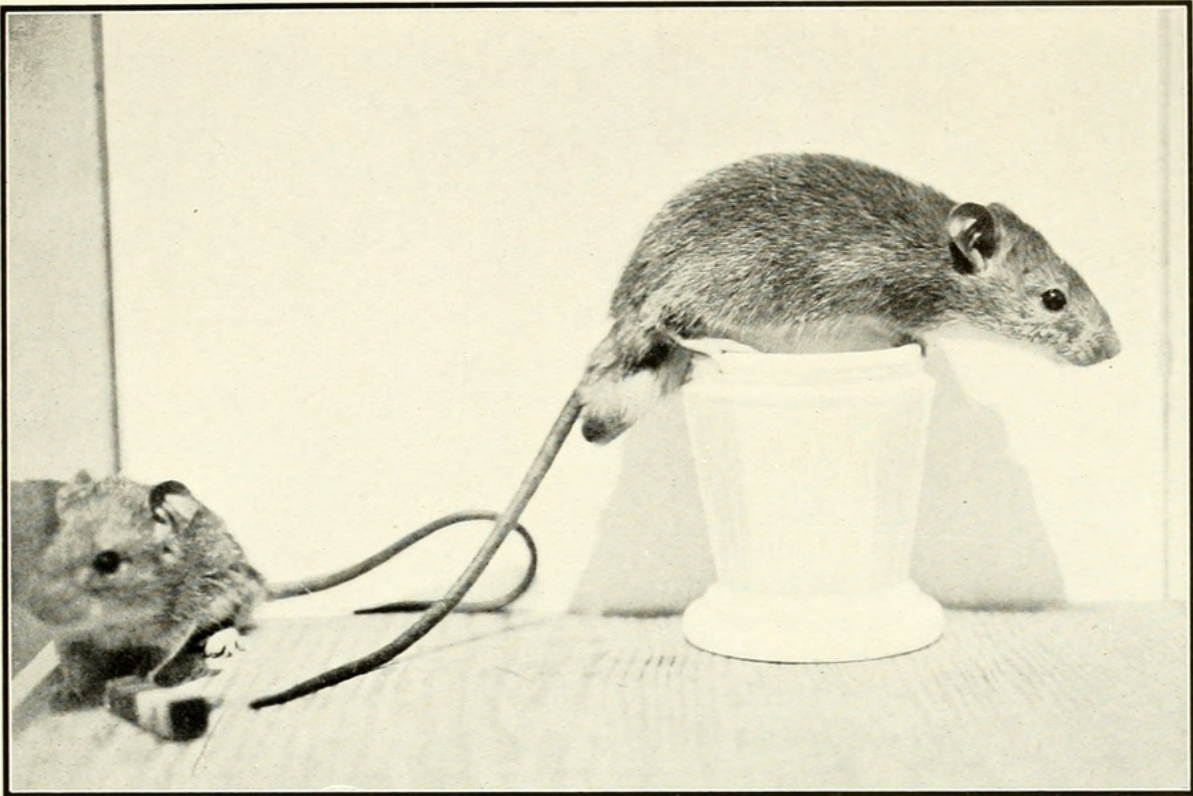
POPOIA ISLET.





POPOIA ISLET.





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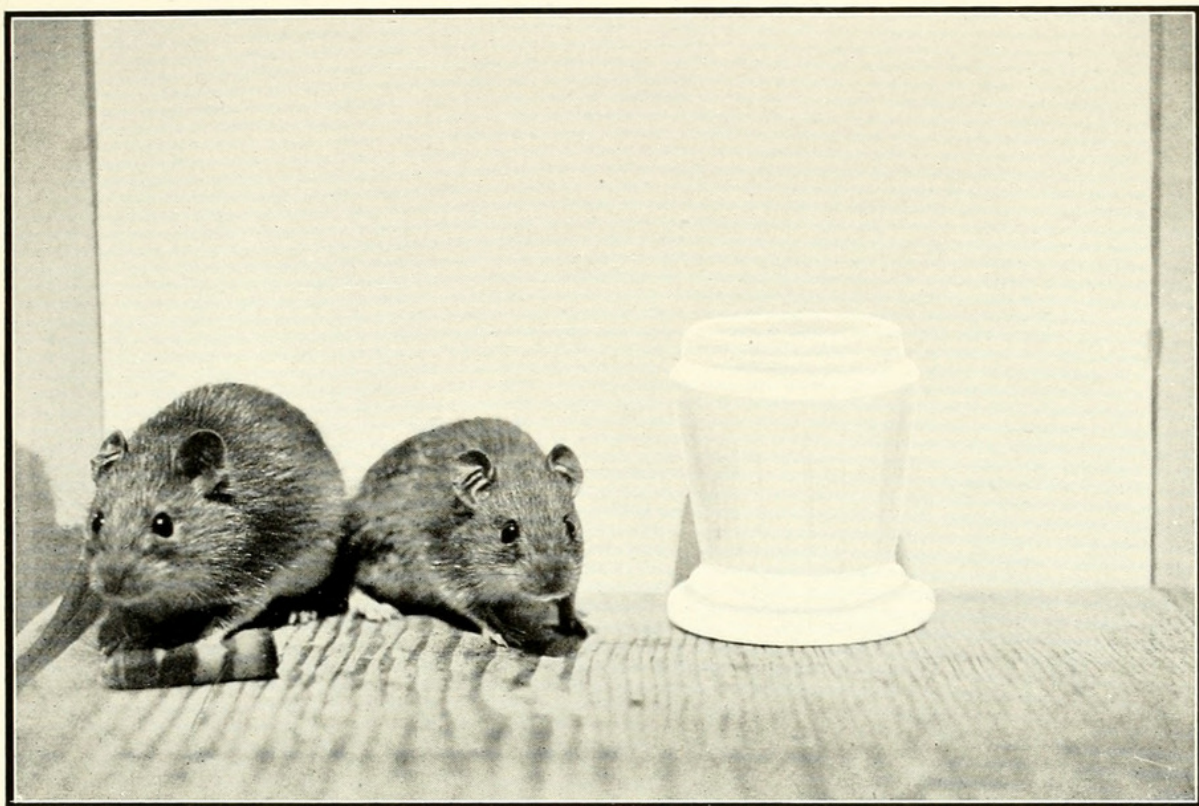


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HAWAIIAN RATS.

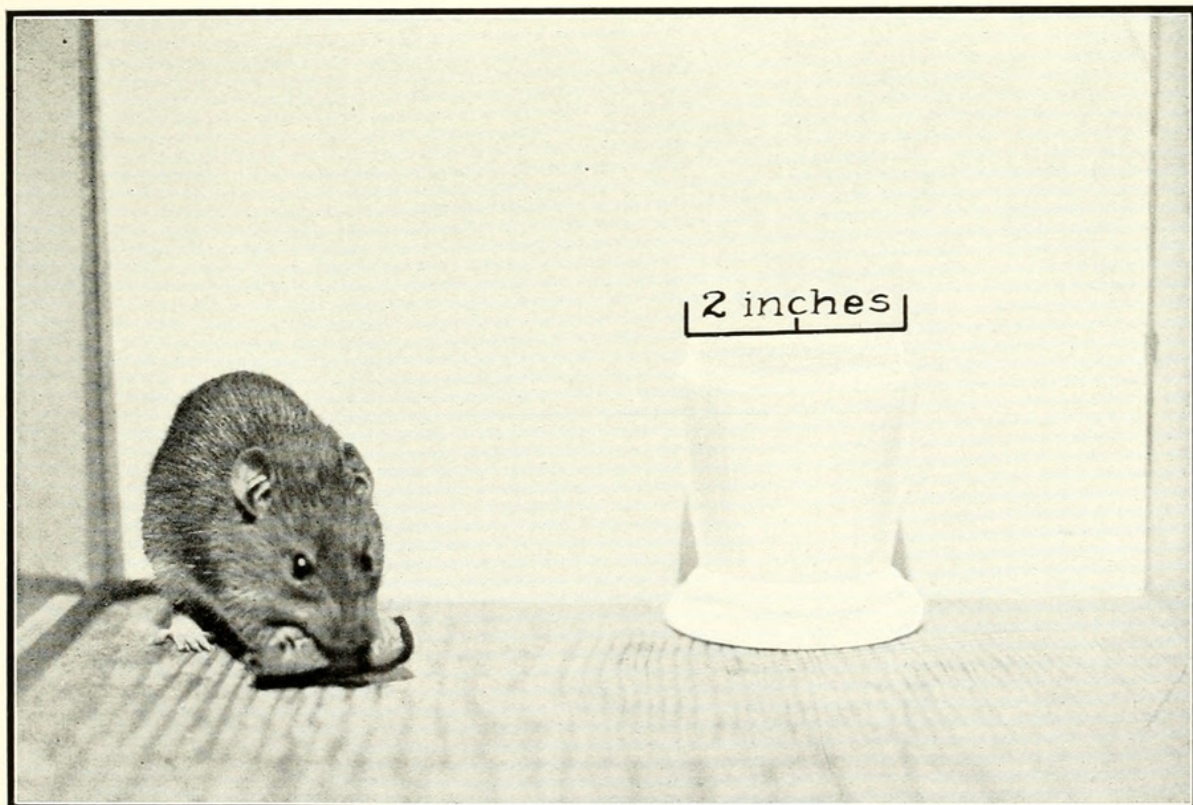
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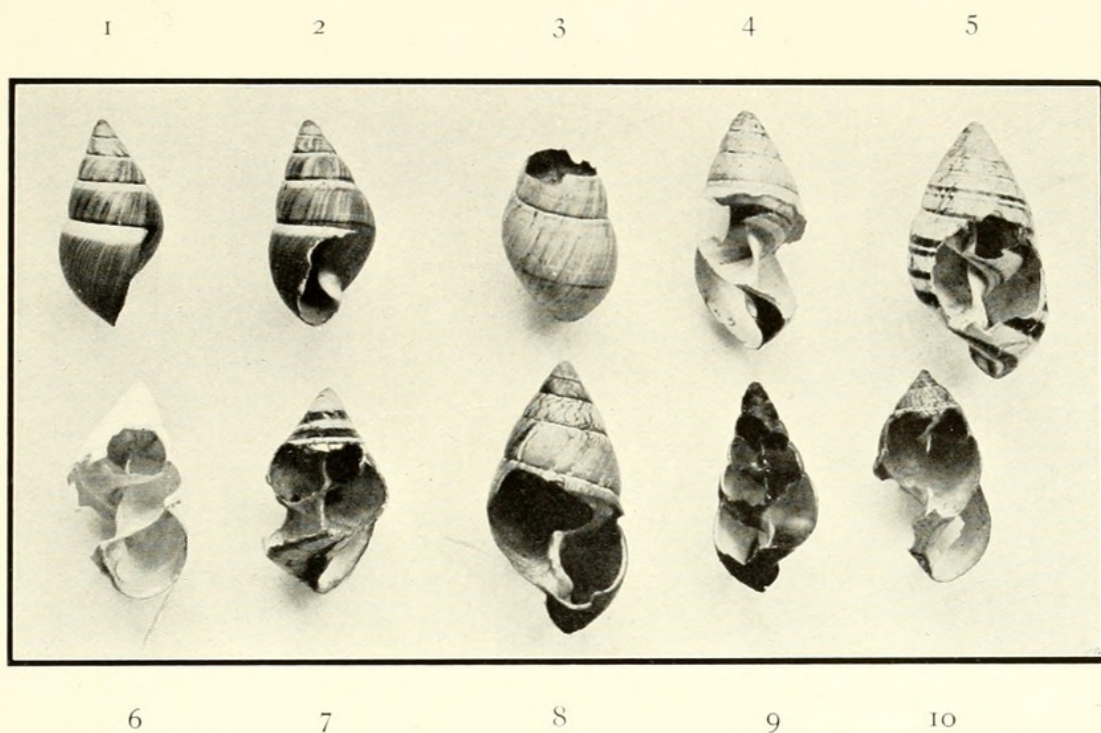
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HAWAIIAN RATS.





HAWAIIAN PULMONATES ATTACKED BY RATS. NO. 2 BY NATIVE RAT  
IN CAPTIVITY; NOS. 3-10 BY INTRODUCED RATS.

- No. 1. *Partulina redfieldii*; whole immature specimen for comparison.  
 No. 2. *Partulina redfieldii*; aperture attacked.  
 No. 3. *Achatinella fulgens*; apex attacked.  
 No. 4. " *fulgens*; ultimate and penultimate whorls attacked.  
 No. 5. " *phaeozona*; ultimate and penultimate whorls attacked.  
 No. 6. " *apicata*, var. *aloha*; ultimate and penultimate whorls  
 attacked.  
 No. 7. *Achatinella apicata*, var. *beata*; ultimate and penultimate whorls  
 attacked.  
 No. 8. *Laminella grandidi*, var. *aurantium*; ultimate whorl attacked.  
 No. 9. *Amastra spirozona*; all but apical whorls attacked.  
 No. 10. *Amastra tristis*; all but apical whorls attacked.  
 All arboreal except No. 10, which is terrestrial.





Stokes, John F. G. 1917. "Notes on the Hawaiian rat." *Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History* 3(4), 261–271.

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