RODENTS OF THE GENERA RATTUS AND MUS FROM THE PACIFIC ISLANDS

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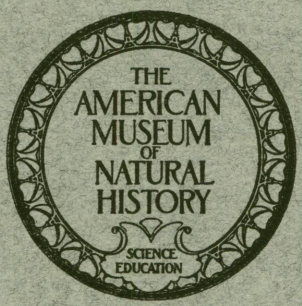

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Article III.—RODENTS OF THE GENERA *RATTUS* AND *MUS* FROM THE PACIFIC ISLANDS, COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION, WITH A DISCUSSION OF THE ORIGIN AND RACES OF THE PACIFIC ISLAND RAT

By G. H. H. Tate

Although the Whitney South Sea Expedition was undertaken primarily with the object of collecting birds, a valuable series of mammals in alcohol and occasional skins and skulls have been included in the large shipments sent to The American Museum of Natural History. These animals, including bats and rodents, may probably be considered a fairly representative sample of the mammalian fauna of the principal island groups of the Pacific Ocean.

I wish to express my appreciation to Mr. Gerrit S. Miller, Jr., U. S. National Museum, for the loan of specimens of *Rattus hawaiiensis*, and for the privilege of examining the large collections in his charge, and to Dr. W. H. Osgood for a similar loan of *Rattus browni* and *hawaiiensis* and material representing other species of *Rattus*.

Four of the five species of rodents in the collections unquestionably represent importations since the arrival of Europeans and Americans. *Rattus exulans*, however, is probably of earlier origin. This rat might be expected to conform more or less to the avian distribution patterns indicated below and to be present on successively fewer islands from west to east. Instead, however, it is widely and rather evenly distributed throughout most of the Pacific groups, a fact that lends support to the view advanced by Waite (1897) and others that in most, if not in all, cases it was conveyed from island to island by Polynesian man. Waite has also shown that it was frequently used for food,[1] has discussed its distribution at length, and has reviewed its records from the various island groups. Our own series (Table I) supplements his list of records materially.

The ornithological collections of the Whitney Expedition have formed the subject of numerous papers by Dr. Robert Cushman Murphy, Dr. Ernst Mayr, and others, and important conclusions have been reached by these workers regarding the bird geography of the South Seas. In a

[1]See also recent opinion of Seurat, 1934, Mem. Soc. Biogeogr., Paris, IV, pp. 44–45.

recent paper Mayr (1933, p. 315) has divided the island groups (exclusive of Hawaii, New Guinea, and the Solomon Islands) into four main groups:

1.—Micronesia, extending from the Palau Islands to the Gilberts.

2.—South Melanesia, from the Santa Cruz group to New Caledonia.

3.—Central Polynesia, with Fiji, Samoa, Tonga, and northward to the Ellice and Phoenix groups.

4.—East Polynesia, including the Cook, Austral, Society, Marquesas groups, and the great Tuamotu Archipelago with its outliers, Pitcairn, Henderson, and Ducie Islands.

Broadly speaking, Mayr finds that the avian populations become progressively more impoverished as one moves from west to east, not only between successive island groups but also in a marked degree among individual islands forming any one group, those islands most remote from the assumed source of population possessing the fewest birds. Those conclusions, though generally applicable among the Chiroptera, do not hold in the case of the cursorial island mammals, owing to the fact that they are all introduced.

Rattus exulans (Peale)

Mus exulans PEALE, 1848, U. S. Exploring Exped., VIII, p. 47.
Mus vitiensis PEALE, 1848, U. S. Exploring Exped., VIII, p. 49.
Mus maorium HUTTON, (1878) 1879, Trans. New Zealand Inst., XI, p. 344.
Mus jessook JENTINK, 1879, Notes Leyden Museum, II, p. 15.
Mus huegeli THOMAS, 1880, Proc. Zool. Soc. London, p. 11.

TYPE.—U.S.N.M. No. 3730, from Tahiti, Society Islands. (Selected by Stone, 1917, p. 258, from several animals from a number of islands listed by Peale under his description of *exulans*.)

TYPE LOCALITY.—Tahiti, Society Islands.

The above synonymy shows that no less than five names have been provided for Pacific Island rats as they have been successively discovered on various islands. Usually the localities have been widely separated from one another: *exulans*, Tahiti; *vitiensis*, Fiji; *maorium*, New Zealand; *jessook*, New Hebrides; *huegeli*, Fiji.

But note that *vitiensis* and *huegeli* are both from Fiji and consequently the latter is likely to be a pure synonym of the former. *Hawaiiensis* Stone from Popoia, Maua, Hawaiian Islands, and *micronesiensis* Tokuda from Ponape, Caroline Islands, are probably both distinct from *exulans*-type rats.

MATERIAL EXAMINED.—(1) The considerable series[1] of 97 specimens (95 in alcohol, but the skulls extracted and cleaned) obtained by

[1]For full list of the Whitney collection see Table I.

the Whitney South Sea Expedition from the principal island groups of the Pacific Ocean, the major part of which, however, is from the Marquesas Islands and the Tuamotu Archipelago. (2) Material representing *Rattus hawaiiensis* and *Rattus browni* kindly loaned by the authorities of the U. S. National Museum, Washington, and the Field Museum of Natural History, Chicago. (3) The large comparative series of *Rattus* in the collections at the U. S. National Museum and the U. S. Biological Survey, examined at Washington.

ANTHROPOLOGICAL RELATIONSHIPS.—I am informed by Dr. H. L. Shapiro of the Department of Anthropology of this Museum that within historical times it has not been customary in Polynesia to carry rats about in canoes, to confine them in cages, or to use them as food, though in Melanesia rats are hunted and eaten with some frequency. I inquired concerning this point because, owing to the very wide distribution of *exulans*, it seemed to me likely that the old time Polynesian navigators deliberately conveyed specimens of the rat from island to island with them. But Dr. Shapiro is disinclined to admit this, preferring the idea that the rats secreted themselves among the stores of coconuts and other foodstuffs on board the very large canoes used for long journeys, and were thus in a sense distributed adventitiously among the islands. Furthermore, Dr. Shapiro considers that although there are recorded many instances of rats being eaten by men, if the animals were at times kept in cages and fed, as would be necessary if their transportation were in any way customary, these facts would be known to ethnological students. Also the principles of random dispersal, even though man were the unconscious agent, ought to have operated, and, in consequence, had the distribution of these rats been of such accidental type, we ought to be able to observe from west to east a gradual decrease both in the proportion of island groups reached by them and in the percentage of islands colonized in any given group. This phenomenon though definitely observable in other organisms, for example among birds (Mayr, 1933), is not noted in the case of the *exulans* rats.

Dr. Shapiro, while observing that a number of theories exist as to the human colonization tracks over the Pacific, states that a broadly accepted view allows two main lines of drift: One entered by way of the Caroline, Marshall, and Gilbert Islands to Samoa, Tonga, and Fiji, whence they were distributed throughout Polynesia. The other line came into Polynesia via New Guinea and the Solomons, to Fiji, Samoa, and Tonga, which served as a center for later migrations. The Maoris represent one of the early waves and are known to have migrated to New

Zealand from the Cook Islands. Besides the above, there is believed to have been communication between Hawaii and the Society Islands, and possibly the Marquesas.

Since they must have been carried by early man, the relationships of the rats ought to follow a dispersal pattern substantially similar to that of man. But as shown below this is not entirely so, for though man crossed the gap from the Solomon Islands to the New Hebrides, the rats appear not to have done so.

TAXONOMIC DISCUSSION.—In order to work out the relationships of the *exulans* rats, it is necessary to secure topotypes of the named forms. Three of these we now have, namely, A. M. No. 48204 from Tahiti (*exulans*) and A. M. No. 69264 from Fiji (*vitiensis* and *huegeli*), unless there be two forms on Fiji. The type locality of *jessook* is Tana, New Hebrides, from which island we have no collections, although material either from Malekula or from Efate may represent it. No example of *maorium* of New Zealand exists, so far as I can learn, in this country. *Rattus hawaiiensis* Stone (1917) and *Rattus micronesiensis* Tokuda (1933) are considered to be distinct species. Before discussing the Whitney series in detail, I wish to note certain characters of the topotype of *exulans*.

DESCRIPTION OF TOPOTYPE OF *exulans* (A. M. NO. 48204, FEMALE) FROM TAHITI

1.—Palatal foramina rather narrow, slightly rounded behind.

2.—Zygomatic plate moderately rounded anteriorly.

3.—Molars moderately broadened, longer than *hawaiiensis*, less broad than *browni*. The tubercle of m^2 (commonly found in *browni*) absent (incipient in the majority of specimens from other islands).

4.—No reduction of the posterior loph of m^3 (as in *raveni* and *eurous*).

5.—Median pterygoid fossa slightly lyrate, about equaled in width by *browni*, *hawaiiensis*, and the larger Philippine species, wider than in *raveni*.

6.—Alisphenoid bar to squamosal moderately thickened as in *raveni*, *eurous*, *basilanus*, *vigoratus*, and *luteiventris* (thinner in *vulcani*, *querceti*, and *browni*), (very thick in *hawaiiensis*). Not much removed from bulla.

The type skin of *exulans* in the U. S. National Museum has the hind foot now measuring 25 to 26 mm.

Because the *exulans* rats have been preserved in alcohol, their variation has been studied mainly through the skull and dentition. A set of measurements was first drawn up (Table VII) from which it was hoped

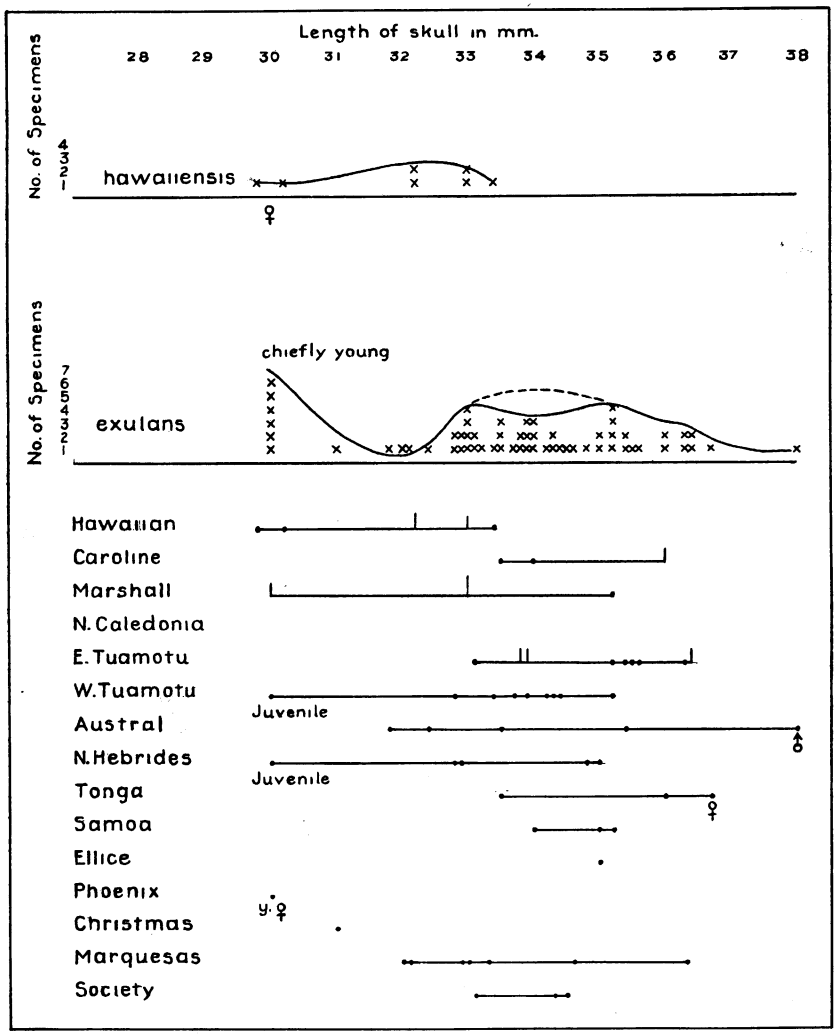

Fig. 1. The upper and lower curves represent *hawaiiensis* and *exulans* respectively. In the lower part of the figure the curves are broken down into their geographical components. Single dots represent single specimens; vertical dashes indicate two or more individuals having identical skull lengths.

to find some clue to the phylogeny of the *exulans*-type rats in relation to their geographic distribution. For this table the sexes were at first grouped separately, but differences due to sexual difference were found to be largely negligible, age differences being far more important. Measurements published by former writers were incorporated into the table, including those given for *hawaiiensis* by Miller and for *micronesiensis* by Tokuda. The best that can be concluded from a study of general measurements is that the eastern islands of the Tuamotu Archipelago and a few other islands seem to be populated by a form definitely larger than the rats of the remaining island groups.

PROPORTIONS OF THE AUDITORY BULLAE.—The characters of the bulla were next considered, and these, I believe, furnish us data of taxonomic importance. Only fifty specimens were found to be fully adult and intact, and thus suited for measurements of the auditory bullae. Four measurements were taken, from which the length and breadth of the bulla and the length of the bony meatal tubercle were computed (see diagram, Fig. 3): (1) lengths of bulla, (2) width across the two meatal tubercles, (3) width across anterior swollen parts of the two bullae combined, and (4) width between inner inflated walls of two bullae. By deducting (3) from (2) and dividing by 2 the width of one bulla was obtained, and by subtracting (2) from (1) and dividing by 2 the extension of one meatal tubercle lateral to the bulla was arrived at. Percentages of width to length of bulla and of meatal extent to width of bulla were calculated, but these, by concealing the absolute dimensions, obscured rather than clarified the situation.

	A.M.N.H. No.	Width meatus (1)	Width bullae (2)	Width apart bullae (3)	Width bulla 2–3 (4)	Length bulla (5)	Meatal ext. 1–2 (6)	Percentages Width / Length bulla	Percentages Meatus / Width bulla
NEW HEBRIDES:									
Malekula	99755	13.2	9.1	3.5	5.6/2 2.8	5.7	4.1/2 2.05	49.1	73
"	99760	13.1	8.9	3.2	5.7/2 2.85	5.9	4.2/2 2.1	48.3	77
Efate	73623	13.4	9.2	3.0	6.2/2 3.1	6.2	4.2/2 2.1	50.8	64
TONGA:									
Kelefesia	99744	13.7	9.8	3.5	6.3/2 3.15	6.1	3.9/2 1.95	51.6	62
Teleketonga	77946	14.8	10.5	3.9	6.6/2 3.3	6.5	4.3/2 2.15	50.9	65
"	77947	14.9	10.6	3.9	6.7/2 3.35	6.5	4.3/2 2.15	51.6	65
PHOENIX:									
Hull	68740	13.5	9.5	3.0	6.5/2 3.25	5.9	4.0/2 2.0	55.0	62
SAMOA:									
Rose	68742	14.2	9.4	3.2	6.2/2 3.1	6.0	4.8/2 2.4	51.7	78
	68747	13.9	9.2	3.1	6.1/2 3.05	5.9	4.7/2 2.35	51.7	77
FIJI	69264	13.4	9.7	2.9	6.8/2 3.4	6.0	3.7/2 1.85	56.6	54.4
SOCIETY:									
Moorea	60643	14.0	9.9	3.3	6.6/2 3 3	6.3	4.1/2 2.05	52.4	62
Scilly	60785	14.2	10.5	3.2	7.3/2 3.65	6.5	3.7/2 1.85	56.2	50
Tahiti	48204	13.2	9.2	3.0	6.2/2 3.1	5.9	4.0/2 2.0	50.8	64.5
AUSTRAL:									
Tubuai	48206	13.5	9.4	3.2	6.2/2 3.1	5.8	4.1/2 2.05	53.4	66
Rapa	99796	14.4	9.9	3.4	6.5/2 3.25	6.1	4.5/2 2.25	53.3	69
MARQUESAS:									
Nukuhiva	63774	14.1	9.8	3.0	6.8/2 3.4	6.7	4.3/2 2.15	50.7	63
Hatutu	99799	13.4	9.4	3.2	6.2/2 3.1	6.1	4.0/2 2.0	50.7	64
"	99717	13.6	9.8	3.4	6.4/2 3.2	6.0	3.8/2 1.9	53.3	60
Fatuhiva	99720	13.4	9.8	3.6	6.2/2 3.1	5.9	3.6/2 1.8	52.5	58
? Island	63776	13.6	9.5	3.4	6.1/2 3.05	6.0	4.1/2 2.05	50.8	67
Fatuhuku	99800	13.4	9.4	3.0	6.4/2 3.2	5.9	4.0/2 2.0	54.3	63
TUAMOTU:									
Tureia	99792	13.6	9.7	3.3	6.4/2 3.2	6.2	3.9/2 1.95	51.6	61
Ahunui	99793	13.0	9.0	2.7	6.3/2 3.15	6.1	4.0/2 2.0	51.6	67
	99794	13.3	8.8	2.9	5.9/2 2.95	6.2	4.5/2 2.25	47.6	76
Aratika	99718	14.6	10.1	4.0	6.1/2 3.05	6.0	4.5/2 2.25	50.8	74
"	99798	13.1	8.9	3.0	5.9/2 2.95	6.1	4.2/2 2.1	47.6	71
Raraka	99763	13.3	9.1	3.0	6.1/2 3.05	5.9	4.2/2 2.1	51.7	69
"	99764	13.6	9.6	3.0	6.6/2 3.3	6.1	4.0/2 2.0	54.1	61
Henderson	99789	14.3	10.0	3.3	6.7/2 3.35	6.6	4.3/2 2.15	50.8	64
	99790	14.3	10.1	3.8	6.3/2 3.15	6.5	4.2/2 2.1	48.5	67
	99788	14.3	10.1	3.6	6.5/2 3.25	6.3	4.2/2 2.1	51.6	65
	99783	14.3	10.1	3.4	6.7/2 3.35	6.5	4.2/2 2.1	51.6	63
	99782	15.0	10.5	3.5	7.0/2 3.5	6.7	4.5/2 2.25	52.3	65
	99773	14.5	10.3	3.4	6.9/2 3.45	6.5	4.2/2 2.1	53.1	61
Hiti	60645	13.6	9.3	2.9	6.4/2 3.2	6.3	4.3/2 2.15	50.8	67
Fakarava	99725	13.7	9.4	2.9	6.5/2 3.25	6.1	4.3/2 2.15	53.3	66
Apataki	99703	13.4	9.3	3.2	6.1/2 3.05	5.8	4.1/2 2.05	52.6	67
Ducie	99784	13.8	9.6	3.1	6.5/2 3.25	6.0	4.2/2 2.1	54.2	65
"	99785	13.7	9.3	3.0	6.3/2 3.15	6.1	4.4/2 2.2	51.7	69
CHRISTMAS ISLAND	48212	13.1	9.4	2.9	6.5/2 3.25	5.8	3.7/2 1.85	56.0	57

SUMMARY OF THE MEASUREMENTS OF THE AUDITORY BULLAE TO SHOW POSSIBLE RACIAL STRAINS

Racial strain of *exulans*	Bulla Length	Bulla Width	Meatus Width	Percentage Width bulla / Length bulla	Percentage Meatus / Width bulla
Henderson	6.1–6.7 (long)	3.05–3.5 (broad)	2.15–2.25 (long)	48.5–54.2	61–74
Ducie	6.0–6.3 (long)	3.05–3.3 (broad)	2.0–2.2 (long)	50.8–54.2	61–69
Raraka	5.8–5.9 (short)	3.05–3.1 (broad)	2.05–2.1 (long)	51.7–53.4	66–69
Ahunui	6.1–6.2 (long)	2.95–3.15 (broad)	2.0–2.25 (long)	47.6–51.6	67–71
Tahiti (*exulans*)	5.9–6.2 (long)	3.1–3.25 (broad)	1.8–2.0 (rather short)	50.7–55	58–64.5
Scilly atoll	6.5 (very long)	3.65 (very broad)	1.85 (short)	56.2	50
Fiji (*vitiensis* and *huegeli*)	6.0 (rather long)	3.4 (broad)	1.85 (short)	56.6	54.4
Samoa	5.9–6.0 (rather long)	3.05–3.1 (broad)	2.35–2.4 (very long)	51.7	77–78
New Hebrides	5.7–5.9 (short)	2.8–2.85 (narrow)	2.05–2.1 (long)	48.3–49.1	73–77

TOTAL LENGTH OF SKULL.—Due to intrusion of growth factors the findings from the graph (Fig. 1) are likely to be less significant than in the case of the molar tooth row. It serves to show, however, that there seem to be rats of two sizes on the Tuamotus, one lot on the western and central islands ranging in skull length from 33 to 34.5 mm., and another in the east varying from 35 to 37. In the Australs the normal length is around 34 mm., but a single male reached 38.[1] On the Marquesas, males, probably of separate races, vary from 33 to 36 mm. On the Fiji groups both sexes reach skull length between 30 to 36.5 mm., and on the New Hebrides males vary from 34 to 35 and females from 29 to 33. The Hawaiian rats include lengths from 30 to 33, the only male measuring 32.

LENGTH OF THE UPPER MOLAR TOOTH ROW.—Comparison of the relative lengths of the upper molar tooth row (drawn up from the general table of measurements) demonstrated the fact that, in the main, rats

[1]The basal length of adult *Rattus alexandrinus* equals 38 mm. or more and of *Rattus norvegicus* exceeds 45 mm.

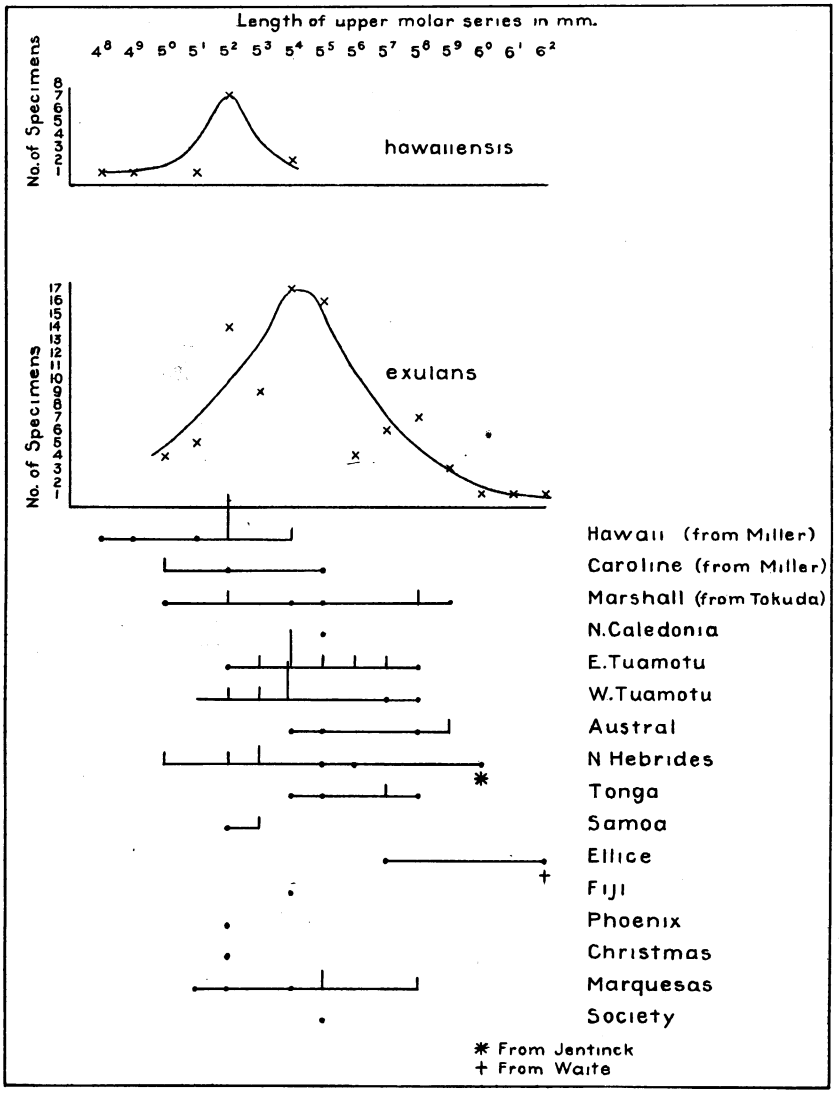

Fig. 2. The upper and lower curves show clearly the difference in tooth dimensions between *hawaiiensis* and *exulans*. The sexes are disregarded. In the lower half of the figure component parts of the curves are shown, dots indicating single specimens, vertical dashes two or more individuals with similar tooth row lengths.

of the various island groups have the length of the tooth restricted within characteristic limits which often overlap those of neighboring island groups but are seldom identical (Fig. 2). The chart shows, however, not only shifts in the tooth row average as between island and island, but it also brings out to some extent the fact that the rats of a given island group are not homogeneous, and to that extent supports the suggestion obtained by studying the bullae. Thus in Tokuda's Caroline Island rats we seem to have but one form, but in his Marshall Island specimens the tooth lengths fall into two groups, one centered about 5.2 mm. and the other about 5.8. Similar groupings can be observed in our series for a number of the island groups, such as east and west Tuamotu, Austral Islands, Marquesas, and the New Hebrides.

The plotting of Miller's figures for *hawaiiensis* shows a distinct shift of the curve to indicate a shorter tooth row, the mode for both males and females being located at 5.2 mm., and the highest measurement being 5.4.

Structural Characters of the Upper Molars.—Search under the binoculars for new characters of the teeth such as accessory tubercles, which might be susceptible to a taxonomic interpretation, proved negative. Among the 50 suitable specimens examined (selected for comparatively unworn dental condition, not the same 50 as were used in the study of the bulla), accessory tubercles between the normal lophs of three main tubercles were found as follows: an internal tubercle between lophs 1 and 2 of m^1 (6 examples); an external tubercle between the same two lophs of m^1 (4 examples) (Fig. 3, A.M. No. 99767-*a*); an external tubercle between lophs 2 and 3 (2 examples); and finally, an internal tubercle between lophs 2 and 3 (1 example). The occurrence of the above tubercles appeared to be purely adventitious and could not be correlated in any way with distribution or genetic strain. In m^2 an external tubercle is usually developed weakly in front of the external cusp of the main (2d ?) loph (Fig. 3, tubercles marked *b*). Rather more rarely (in 11 examples) it is strongly developed, as in *browni* of New Guinea and the Solomon Islands, and in 8 specimens it is very weakly developed or absent. In m^3 the posterior tubercle, though drawn out from side to side, is commonly entire, but in 11 skulls it showed partial fission and in one (A. M. No. 68742) it had divided in two (Fig. 3, *d*.) None of these characters was of assistance from the standpoint of the taxonomy of the groups of *exulans*.

TABLE TO SHOW ACCESSORY TUBERCLES OR DENTAL PECULIARITIES OF *Rattus exulans*

	A.M.N.H. No.	M^1				M^2			M^3		
		External		Internal		External Tubercle Anterior to 1st loph			3d loph		
		Between lophs 1 and 2	Between lohps 2 and 3	Between lophs 1 and 2	Between lophs 2 and 3	Absent	Sl ly developed	Well developed	Broadened but undivided	Slightly divided	Well divided
NEW HEBRIDES											
Malekula	99756		+				+		+		
"	99759						+			+	
"	99760	+	+				+		+		
"	99757							+	+		
Torres, Hiu	79992						+		broad-ened		
Efate	73623						+		+		
TONGA											
Lalona	77947							+		+	
Teleketonga	77946	+					+		+		
Kelefesia	77945	+				+				+	
"	73624			+					+		
PHOENIX											
Hull	68740						+			+	
SAMOA											
Manua	68748							+	+		
Rose	68747					+				+	
"	68742					+					+
SOCIETY											
Scillv	60785			+			+		+		
Moorea	60643						+		+		
Tahiti	48204					+			+		
AUSTRAL											
Raivaivae	48210							+	+		
Rapa	48209						+			+	
"	99787						+		+		
"	99796						+		+		
MARQUESAS											
Tiakara	99768			+			+		+		

TABLE TO SHOW ACCESSORY TUBERCLES OR DENTAL PECULIARITIES OF *Rattus exulans*—(*Continued*)

	A.M.N.H No.	M^1 External: Between lophs 1 and 2	M^1 External: Between lophs 2 and 3	M^1 Internal: Between lophs 1 and 2	M^1 Internal: Between lophs 2 and 3	M^2 External Tubercle Anterior to 1st loph: Absent	M^2 External Tubercle Anterior to 1st loph: Slightly developed	M^2 External Tubercle Anterior to 1st loph: Well developed	M^3 3d loph: Broadened but undivided	M^3 3d loph: Slightly divided	M^3 3d loph: Well divided
MARQUESAS											
Tiakara	99769						+		+		
Nukahiva	63774							+		+	
Traita	99767			+			+		+		
Fatuhiva	99720					+			+		
TUAMOTU											
Hita	99761	+			+	+			+		
"	99762					+			+		
Tepoto	99704						+		+		
Raraka	99764						+			+	
"	99716						+		+		
Ariteka	99798					+			+		
"	99718							+			
"	99765							+			
Ahunui	99794			+				+	+		
Tiakara	99769						+		+		
Tureia	99793						+		+		
Taenga	99766							+			
Maria	99777						+		+		
"	99780						+		+		
"	99778						+			+	
"	99774			+			+		+		
"	99776						+		+		
"	99713						+		+		
Henderson	99781							+	+		
Ducie	99784						+		+		
"	99785						+		+		
"	99791						+			+	
"	99770							+	+		
CHRISTMAS ISLAND	48212						+			+	

It should be mentioned that the teeth of these rats have been affected by caries in several cases. I believe that this condition has only been previously reported for *Rattus rattus*, *R. norvegicus*, and *Mus musculus*.

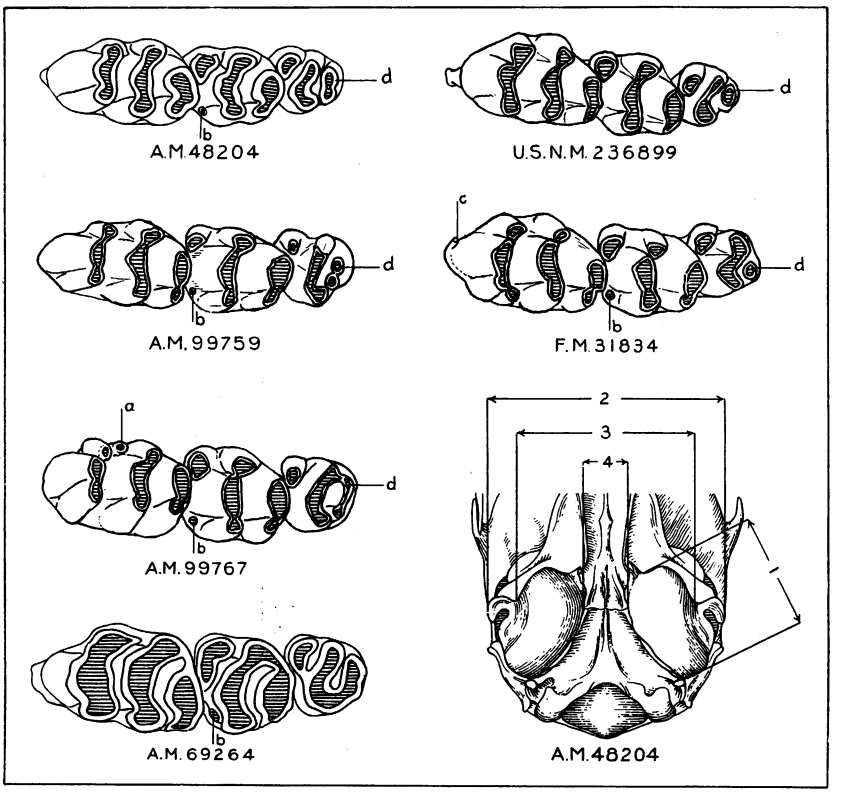

Fig. 3. Right upper tooth rows of A. M. No. 48204, topotype of *R. exulans;* A. M. No. 99759, *exulans* from Malekula, New Hebrides, to show partly divided posterior loph of M^3 (d); A. M. No. 99767, *exulans* with accessory cusp (a); A. M. No. 69264, topotype of *R. vitiensis* and of *huegeli;* U. S. N. M. No. 236899, *R. hawaiiensis;* F. M. No. 31834, *R. browni.*

Auditory bullae of topotype of *exulans*, A. M. No. 48204, to illustrate measurements taken for comparison of dimensions of bulla and meatus (p. 150).

The carious condition occurs in four specimens, three from the Tuamotu and one from the Marquesas group.

Comparing the dentitions of unworn specimens of *hawaiiensis*, the *exulans* rats, and *browni*, I find the individual teeth of *browni* longer and narrower and those of *exulans* broader and shorter than is the case with

hawaiiensis. Peculiarities of individual teeth of *exulans* are shown in the previous table and line drawings (Fig. 3) but, as is indicated, these peculiarities are often far from being constant and in most cases represent merely individual variation. The inferior teeth of all three species are remarkably alike.

COMPARISON OF UPPER MOLARS OF *Rattus exulans* AND ALLIES

	browni	*exulans*	*hawaiiensis*
M^1	A tendency to develop accessory tubercles between the external ends (tubercles) of each of the three transverse lophs. A distinct anterior cingular tubercle.	Rarely such tubercles as in *browni*. No anterior cingular tubercle. Rarely an accessory tubercle between the internal ends of lophs 1 and 2. (See previous table.)	Without tubercles of *browni* and *exulans*. No anterior cingular tubercle.
M^2	With small accessory tubercle anterior to outermost tubercle of second loph.	With the accessory tubercle of *browni* commonly incipient.	Without accessory tubercle of *browni*.
M^3	Third loph commonly formed by a single tubercle, free from second loph. Inner and outer tubercles of second loph subequal in size, and a well-defined anterior groove between them.	Third loph commonly formed of two partly united tubercles. Rarely united with second, either by inner or by outer tubercle. Inner tubercle of second loph usually smaller than outer one.	Third loph formed by single tubercle, free from second loph. Inner tubercle much smaller than outer one of second loph.

THE GROUPS OF *exulans*.—Having essayed several lines of approach, namely, through proportion of bullae, length of molar tooth row, length of skull, and structure of molars, we may now try to integrate the results of these studies in order to see whether they will support one another and thus allow definite conclusions to be drawn regarding possible differentiation. Below I have tried to summarize these results in tabular form. It is at once obvious that the bulla alone is susceptible of even moderately satisfactory interpretation, the other characters overlapping to a high degree and being useful only in a confirmatory capacity. One gains a distinct impression that a number of separate strains that preserve a greater or less measure of integrity are present among the islands. An

example of this type, I believe, is the form on Malekula Island, New Hebrides, which possesses a small, proportionately narrow bulla and a proportionately long meatal tubercle. Another is the larger rat of Rose Island of the Samoan group, with rather large bulla, proportionately longer and broader than that of the Malekula Island rats and also with very long meatal tubercle.

Were I to reduce the number of these groups further, I would first isolate as *exulans* the small-sized animals with large bulla and short meatus, making the large Tuamotu rat and the Raraka, Samoan, and Fiji rats variants of it. The Malekula rats of New Hebrides I would consider more distant on account of their peculiarly small bullae and long meatus.

It will at once be objected that the above divisions in practically every case are based upon very meager series. But one must use what is at hand, and I feel, in spite of a certain vagueness of the characters pointed out, that there is a considerable basis of truth in this classification. Representatives of some of the groups seem to have spread rather widely. Thus the large Tuamotu rat is present on Teleketonga of the Tonga group, on Moorea of the Society Islands and on Nukuhiva of the Marquesas, as well as Aratika, Raraka, Hiti, and Fakarava of the west or central Tuamotu Archipelago. But its headquarters seems to be Henderson and Ducie of the east Tuamotus and Rapa of the Austral Islands, where perhaps it is exempt from intermixture and competition with the smaller *exulans* and Raraka rats. There is as yet no record of *exulans* from Easter Island, farther east, but I should expect this large race, rather than any other race, to have been taken there, perhaps by the people who carved the stone images of the Island.[1]

Of the seven strains distinguished above, the two most strikingly separable seem to be No. 2, the large Tuamotu form, and No. 7, the variety from Malekula Island, New Hebrides. Those perhaps represent relict forms which persist only on the periphery of the principal assembly of Pacific rats.

In view of the fact that the Maoris are believed to have migrated from the Cook Islands to New Zealand, it seems probable that *maorium* will be found most closely related to one of groups 1, 2, or 3.

One can scarcely doubt that the majority of these strains of rats hybridize readily when opportunity offers, so that the greater part of the groups under consideration are likely to be of mixed origin. Since this would be most pronounced wherever communication between the natives

[1]See comparisons in stone workings attested by Raven, 1926, Natural History, XXVI, pp. 272–282.

POSSIBLE RACIAL GROUPS OF *exulans*, BASED UPON THE STRUCTURE OF SKULL AND TEETH

	Size of Rat	Bulla		Meatus	Molar Row Length	Length of Skull
1. Society—Marquesas (including topotype of *exulans* from Tahiti)	moderate	long	broad	short	5.2-5.7, with mean around 5.4 to 5.5 (topotype = 5.5)	32.0-33.1 (topotype 33.1)
2. Tuamotu—Austral	moderate to large	long	broad	r. short	5.2-5.8 (average 5.5)	33.0-38.0
3. Scilly atoll (Society Group)	moderate	v. long	broad	v. short	5.5	34.5
4. Raraka	moderate	short	broad	long	5.1-5.5 (average of 3 = 5.3)	31.8-33.9
5. Samoa	r. large	r. long	broad	v. long	5.2–5.3 (2 specimens)	34.0-35.2
6. Fiji (topotype of *huegeli* and *vitiensis*)	moderate	r. long	v. broad	short	5.5	34.8
7. New Hebrides (nearly topotypical of *jessook*)	moderate	short	narrow	v. long	5.2, 5.6	35.0

of different islands and island groups was greatest, we may conclude that the Society—Marquesas, or *exulans* division, rats having a relatively short meatus, is probably a highly mixed group which appears to have spread to the western Tuamotus, Christmas Island, the Phoenix group and (?) to Efate, New Hebrides.

The Raraka and Scilly atoll animals are forms perhaps bordering on *exulans* proper. The Fiji Island rats are represented by a single specimen (A.M. No. 68764), which, providing there is but a single racial strain on Fiji, is topotype both of *vitiensis* and of *huegeli*. The skull, which is that of a female, is relatively heavily built, has a rather massive rostrum, and is distinct from the Tongan and Samoan rats, its nearest neighbors. The type skin of *vitiensis*, in the U. S. National Museum, has a hind foot that now measures 30 mm. Just as in *exulans*, the tail has scale hairs equal in length to one and one-half to two scale lengths, the hairs above dark, those beneath white.

HAWAIIAN AND CAROLINE ISLAND FORMS OF *exulans;* ALSO *Rattus hawaiiensis* AND *micronesiensis*.—Before turning to the question of the origin of the rats of the Pacific, some further factors must be taken into account. These are (1) the rats from Popoia, Oahu, Hawaiian Islands; (2) the common rat of the larger Hawaiian islands, of which a dozen from each—Oahu, Maui, and Hawaii—have recently been collected by Dr. Eskey and sent to Washington; (3) the rat of Ocean Island at the extreme west of the Hawaiian chain, some 1200 miles from the main group, a considerable series of which were secured by Dr. Wetmore of the U. S. Biological Survey; (4) the "*exulans*" of Tokuda from the Caroline and Marshall Islands; and (5) *Rattus micronesiensis* Tokuda from Ponape, Caroline Islands.

The skulls of *hawaiiensis* from Popoia are immediately to be distinguished from any hitherto discussed by their smaller size, shorter, more widely separated tooth rows, short rounded bullae, differently formed zygomatic plate, lack of accessory dental tubercles, undivided last cusp of m^3, and rather spinous fur.

The mainland rats collected by Dr. Eskey seem different from those of Popoia on account of their different "make." Their pelage appears less spinous and longer haired, and, taken with other specimens from the main islands, they evince a seasonal color change from more cinnamon to more grayish, as do also the Popoia rats. Although I could discover no anatomical difference from the Popoia animals, I obtained rather a different set of measurements from those of Miller for the Popoia rats (Table VII, p. 172).

Ocean Island rats belong to the Pacific rat type rather than to the Hawaiian rat type. It was suggested to me recently that because Ocean Island is periodically swept by hurricanes the rat fauna would be periodically destroyed, and in consequence the present rat colony must be lately introduced. I am permitted to quote from a letter in which Dr. A. Wetmore was good enough to express his opinion. Referring to Green Island, Ocean Island, he writes:

> This island at its highest point lies from twenty to twenty-five feet above high tide mark. It is surrounded by sand beaches back of which there are knolls of sand covered in the main with a dense growth of a shrub sometimes called beach magnolia (*Scaevola*). In the center there is a grass-grown opening of fair size. A smaller island, called Sand Island, has less elevation and no shrubby vegetation, as it is evidently swept regularly by high water.
>
> I have little doubt that hurricanes on occasion sweep Green Island . . . at such times, I presume that waves inundate the land though I have no definite records to that effect. Probably the outer reef breaks the force of the water . . . .Even though the island is swept on occasion by water, I see no reason to suppose that the small rat may not have been able to persist. These creatures climb readily and the small stock might be saved in some hollow tree trunk. That the island population of rats is replaced regularly I doubt exceedingly as even now there is little traffic to this island. It is my assumption that the present stock of rats came there long ago

Writing of Wake Island north of the Marshall group, Dr. Wetmore mentions the presence of "a flightless rail peculiar to this one atoll. I assume that if these rails could exist the rats must likewise have been able to maintain themselves."

The rats of Ocean Island have well-inflated bullae, a wide pterygoid fossa, more projecting zygomatic plate, and less proödont incisors than *hawaiiensis*. They lack a postnasal spine.

Considering the *exulans*-like character of the rats on Ocean Island, I would expect the rats recorded by Tokuda from the Caroline and Marshall Islands to belong with the Pacific Island rats, and this view is strengthened by the presence in Tokuda's diagram (p. 81) of a notch in the posterior loph of m^3, in perfect agreement with the usual condition of that tooth in the *exulans*-type rats. His half-tones (Pl. v) are scarcely clear enough to form the basis of an opinion, but the skulls illustrated appear to me to have widely flaring meatal tubercles and thus to agree with my groups, 4 (Raraka), 5 (Samoa), and 7 (New Hebrides). But the bulla appears wide, thus eliminating group 7. In all likelihood Tokuda's animal will prove to be a mixed group allied to the Samoan and Tuamotu rats. The wide variation in such measurements as length of tooth row (5.0–6.3 mm.) and length of bulla (5.5–7.0 mm.) indicate a mixed strain.

His numbers 1, 7, and 10, all from the Marshall Islands, suggest the large Tuamotu rats.

Micronesiensis from the character of its "bullae narrow and high," recalls one of the smaller members of the *concolor* group of the Philippines or *raveni* of the Celebes. Its wide palate is similar to that of *hawaiiensis* (which can otherwise be ruled out on account of the bullae). It seems from the plate to have a rather widely extended meatal tubercle. There is in the Philippine Islands a group of small species—*leucophaeatus*, *ornatulus*, *pantarensis*, and *basilanus*—to which it is possibly allied, and it tallies with this group in foot length, though its tooth rows are very slightly longer.

THE *concolor* GROUP AND RELATIONSHIPS OF THE PACIFIC ISLAND RATS.—When a comparison of *hawaiiensis*, *micronesiensis*, and the several races of *exulans*-type rats is made with other members of the *concolor* group to which they unquestionably belong, very little hint of relationship to any one species more than to another can be gained. And indeed, an analysis of the whole group is needed before their position can be satisfactorily determined.

The "*concolor*" group of *Rattus*, so far as it can be characterized at all, is an assemblage of quite small, brownish or grayish rats with whitish or buffy under parts, commonly possessing a greater or less development of spinous hairs mixed with fur and with the tail usually but not always slightly shorter than the body. Females of this group invariably have two pairs of pectoral and two pairs of inguinal mammae. No trace of opposability in the hallux can be noted. The skull and teeth appear practically unspecialized. The length of the skull ranges from about 29 to 38 mm. The *concolor* group converges upon several South Asiatic and Malaysian groups of rats among which may be mentioned *cremoriventer*, *fulvescens* (=*jerdoni* ?), and *asper*.

The geographical ranges of these groups appear to be respectively as follows:

concolor group:—Tenasserim, Malay States, Sumatra, Java, Borneo, Philippines, Celebes, New Guinea, eastward from these lands over almost the whole of the Pacific Islands and New Zealand.

cremoriventer group:—Siam, Jalor, Annam, Cochin, Tenasserim, Malay States, Sumatra, Java, Borneo, Bali (absent from the Philippines).

fulvescens group:—Fukien, Yunnan, Indo-China, Burma, Nepal, Sikkim, Siam, Tenasserim, Johore, Sumatra, Java, Borneo, Celebes (also absent from the Philippines).

The following notes are drawn up from three specimens of true *concolor*, U.S.N.M. Nos. 152189, 240541, and 111981, the typical species of the group, which inhabits Siam, Tenasserim, and the Malay region.

1.—Skull medium in size, greatest length 29.5 mm. Zygomatic breadth 14.5 mm.

2.—Palatal foramina slitlike, rather pointed at both ends, 5 mm. (up to 5.9) or slightly less in length, occupying two-thirds of diastema (7.5 mm.), posterior end level with front of m^1 root.

3.—Muzzle narrow, rather short, front of zygomatic plate distant from anterior edge of premaxilla 6.6 mm., and from front of orbit (below) 9.6 mm.

4.—Zygomatic plate thrown forward, rounded; infraorbital foramen well opened above.

5.—Molar series (alv.) approximately 5.0 mm.

6.—Bullae large and rounded, 5.6 mm. × 4.0 mm. (to meatus), 2.6 mm. apart across basioccipital.

7.—Median pterygoid fossa of moderate width, not lyrate in form; sides nearly parallel; palatal edges rounded to meet in a slight postnasal spine.

8.—External pterygoid wings of alisphenoid slightly variable (?); broader in specimen from Selangor; narrower in one from Indo-China (Luang Prabang).

9.—Occiput not greatly produced.

10.—Well-marked temporal beading.

11.—Posterior edge of mandible between articular and angular processes well excavated; and a well-developed coronoid spine.

Skin crisp-haired with short spines. Length of ears moderate, 13–14 mm.; feet, 24, 23.5, 25.5 (=23.5–25.5). Tail slightly longer than head and body. $\frac{\text{Tail}}{\text{Head and body}} = \frac{\text{“122”}}{\text{“94”}}$ or, remeasured on the study specimen, $\frac{109.}{116}$ Tail hairs three, subequal (median slightly longer), about two scales in length, black dorsally and white ventrally.

Colors dull grayish brown above, dull brownish buffy beneath, the ventral hairs very short; gray bases relatively long; brown tips occasionally worn away. Throat occasionally without gray bases to hairs. Feet pale buffy brown. Juveniles with pelage rather long. The group as a whole is readily separated from allied groups, *cremoriventer*, and *asper*.

Distinguishing characters of groups of *Rattus* allied to *concolor:*

1.—*Concolor*, with large rounded bullae and narrowed basioccipital; palatal foramina slitlike to rather rounded behind; moderate to short tail; fur spinous or not so; feet moderate in length.

2.—*Asper*, with small bullae and wide basioccipital; short rounded palatal foramina; short tail; heavily spinous pelage; long feet.

3.—*Cremoriventer*, with small bullae and wide basioccipital; moderately shortened, but wide palatal foramina; extremely wide pterygoid fossa; very long, well-haired tail; moderately spinous hair; short feet.

The New Guinea species *browni* which is currently placed in the *concolor* group is characterized by a well-developed extra cusp in m^2, a short tail, heavy spines, and a lack of soft fur.

Species adjoining the Pacific area referable to the *concolor* group, with the regions occupied by them, are as follows:

PHILIPPINES:
1.—Small, heavily furred, nearly spineless, *calcis*, *negrinus*
2.—Large, moderately furred, *querceti*, *vigoratus*, *vulcani*, *todayensis*, *mayonicus*
3.—Small, short furred, *leucophaeatus*, *ornatulus*, *pantarensis*, *basilanus*
4.—*Luteiventris*

BORNEO:
concolor subspecies
trachynotus ?
schuitemakeri ?

CELEBES:
raveni raveni, *raveni eurous*

FLORES:
wichmanni ?

NEW GUINEA:
browni
concolor lassacquerei

It will be noted that in all regions, except in the Philippines, species are few (the mainland, Sumatran and Javanese animals are chiefly forms of *concolor* and *ephippium*). This is perhaps due to the relative development of competing species of the *cremoriventer* and *fulvescens* groups. In the Philippines, on the contrary, where those groups are absent, the *concolor* group has speciated freely. The accompanying map (Fig. 4) indicates the probable course of divergent evolution in the *concolor* group. *Browni* of New Guinea and the Solomon Islands appears to be a peripheral species which has failed to enter North Australia. At least I have failed to find it or any representative of the *concolor* group among the collections of Raven and of Hoy. Of *wichmanni* I know nothing beyond the descriptive notice.

Considerable evidence is adduced by Dickinson (1928, pp. 273–289) and others to the effect that the Philippines were rather recently (late Tertiary) linked with Palawan and Borneo, and Borneo with Java, Sumatra, and the Malaysian mainland, Celebes having been more remotely connected. It is probable that the present Philippine radiation

was initiated before severance of these islands had been completed. Some evidence is available in confirmation of this view in the presence of what I believe are representatives of the large Philippine mountain section of *concolor* (*vigoratus*, *todayensis*, etc.) on the mountains of Java (specimens in U.S. National Museum). Not improbably the section is represented on the higher mountains of Borneo, though as Raven's Borneo collection is from the lowlands only, and I have been unable to relate any of Thomas's species to the mountain *concolor* group, I am uncertain on this point. In Raven's mountain collection from the

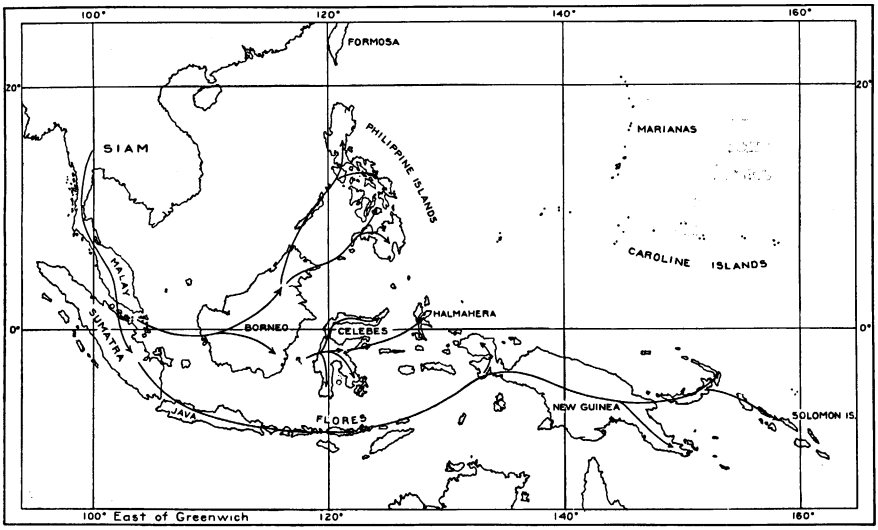

Fig. 4. Schematic view of the distribution tracks of the *concolor* group (except the Pacific Island forms) from a postulated place of origin in the Burma–Siam area.

Celebes there is no representative of the *concolor* group, *raveni raveni* and *raveni eurous* being both lowland species.

I am inclined then to look upon this high mountain section of the *concolor* group of rats as a relict fauna, whose spread into the lowlands is opposed by the lowland *concolor* species *leucophaeatus*, etc.; *luteiventris;* and true *concolor* and *ephippium* with their geographical races. These mountain species may be viewed as peripheral to the lowland forms in an altitudinal sense, just as *browni* of New Guinea is peripheral in a geographical sense.

Finding that *exulans* matches the Philippine mountain forms rather closely, I am inclined to consider the several Pacific members of the

concolor group, excepting *micronesiensis*, as belonging to this same grade of relationship. I would suggest a similar concentric arrangement in the Pacific (map, Fig. 5), the newest arrival and at present dominant portion being perhaps the typical widespread *exulans*, with an older remnant in the New Hebrides, another (*hawaiiensis*) on Popoia, and a third represented by the large Tuamotu rat, Tokuda's large Marshall Island rats and (possibly) *maorium*. I would thus derive *exulans* and *hawaiiensis* from the Philippine-Borneo-Java region in the form of many successive waves probably arising from stocks already differentiated from each other. I am not inclined to believe that any one of them has passed through New Guinea.

Rattus rattus alexandrinus (Geoffroy)

Mus alexandrinus GEOFFROY, 1803, Cat. Mammif. Mus. Nat. d'Hist. Nat., Paris, p. 192.

Recently, Aharoni (1932, pp. 178–181, 229) has shown that two forms of rat have been confused under the name *alexandrinus:* "a gray bellied and gray-brown backed form" of Egypt, Palestine, and Syria, which she has recognized as true *alexandrinus* Geoffroy; and a "white bellied, dark brown backed form" from Italy, Syria, and part of Palestine, to which she has applied the name *frugivorus* Rafinesque, with synonym *tectorum* Wagner. She has considered both to be subspecies of *rattus*. In the present collections only true *Rattus r. alexandrinus* has appeared. It seems to be abundant whenever established. (See Table II for records obtained by the Whitney Expedition.)

Rattus rattus rattus (Linnaeus)

Mus rattus LINNAEUS, 1758, 'Syst. Nat.,' 10th Ed., I, p. 61.

The black rat occurs only twice in the collection, and from localities more than 1500 miles apart. Probably this form is only moderately common on account of constant crossing with *alexandrinus*. In South America I have sometimes found it locally abundant in rather new clearings in the forest. (See Table III for records secured by the Whitney Expedition.)

Rattus norvegicus Berkenhout

Mus norvegicus BERKENHOUT, 1769,[1] 'Outlines Nat. Hist. Great Britain,' I, p. 5.

The Norway rat seems to be slower than *alexandrinus* to colonize. The Whitney collections contain only six specimens, all from the East-Polynesian[2] division (see Table IV).

[1]From Cabrera, 1932, Trab. Mus. Nac. Cien. Nat., Ser. Zool., Num. 57, p. 264. The origin of *norvegicus* has commonly been attributed to Erxleben, 1777.
[2]See Mayr.

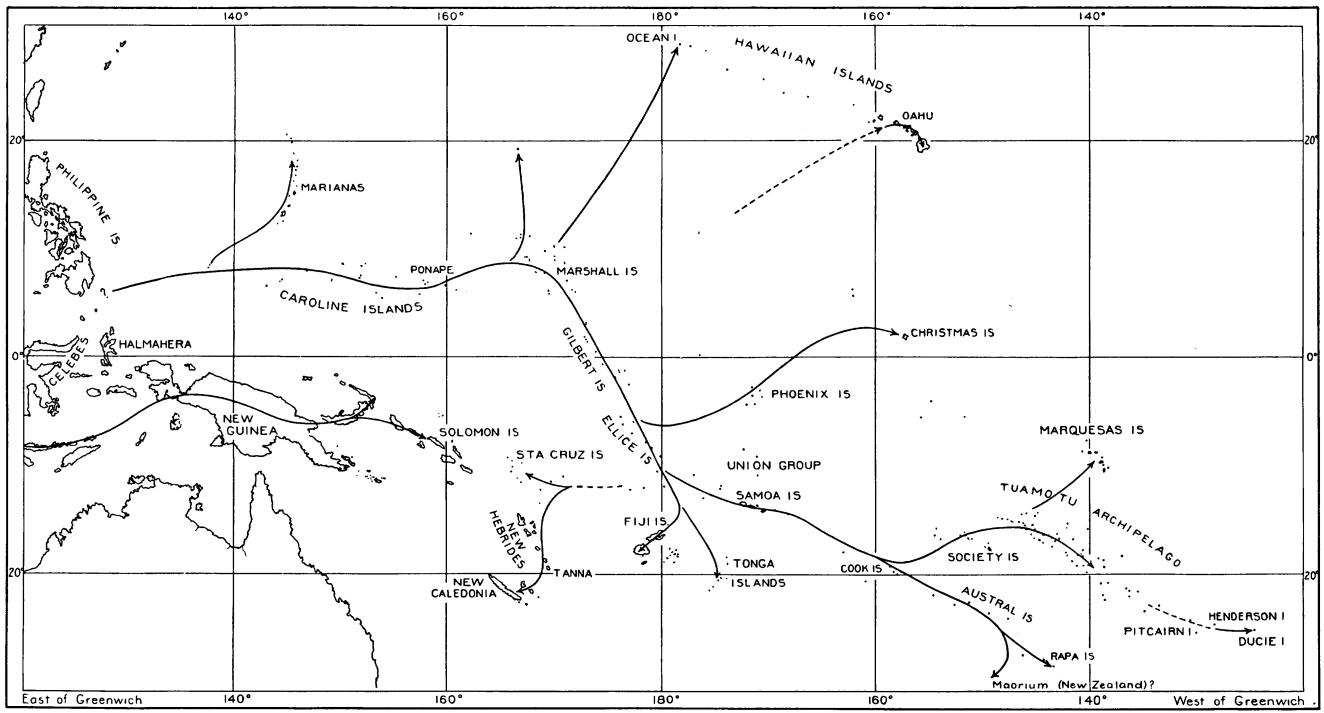

Fig. 5. Generalized plan of migration tracks followed by successive waves of *exulans*-type rats when permitted by human migratory movements. The disconnected dotted lines leading to Hawaii, New Hebrides, and the eastern Tuamotu Archipelago indicate what are believed to be remnants of still earlier colonizations.

Mus musculus Linnaeus

Mus musculus Linnaeus, 1758, 'Syst. Nat.,' 10th Ed., I, p. 59.

The house mouse is represented in the Society, Tuamotu, and Marquesas groups each by a single specimen. It has almost certainly a much wider distribution in the islands. Revilliod[1] has described a new subspecies from New Caledonia and the Loyalty Islands. (Table V.)

Summary and Conclusions.—Except for the ship-borne *Mus musculus*, *Rattus norvegicus*, *Rattus rattus rattus*, and *Rattus rattus alexandrinus*, the only group of rats that has colonized the Pacific Islands is the Malaysian *concolor* group. None of the island members of this group is identical with any living mainland, Bornean, Philippine, Celebesian, or New Guinean species. The animals as a whole tend to be slightly larger than most of the mainland forms and reach comparatively large size in the extreme east and south of their range. Anatomically slightly specialized forms usually unworthy of nomenclatorial separation, probably representing early colonizations, are present on the Hawaiian Islands, and Tuamotu-Austral Islands, and on the New Hebrides. On the remaining groups of islands, less specialized but still divergent forms occur, the exact status of which is obscured by frequent crossing and by the probability that they originated from different racial strains arriving in the islands at different times. Since all have been carried by man, whether voluntarily or involuntarily, they must have followed his colonization tracks; yet in the case of these island rats the general laws of dispersal seem to have been interfered with, so that, contrary to the case in most organisms, no noticeable diminution of the number of forms developed or numbers of islands reached from west to east is to be perceived. Most of the colonization was achieved before the advent of white men; lately due to deterioration in the quality and quantity of native boat building the mixing process has fallen off. The original course from the mainland was probably from Borneo and the Philippines via the Caroline Islands rather than through New Guinea and the Solomon Islands.

[1]Revilliod, P., 1914, 'Nova Caledonia,' I, pp. 364–365.

TABLE I.—LOCALITIES OF *Rattus exulans* WITH NUMBER OF SPECIMENS COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

MARQUESAS ISLANDS	1	AUSTRAL ISLANDS	
Apataki	1	Rapa	5
Ariteka	3	Raivaivae	1
Fakuhuku	1	Tubuai	3
Fatuhiva	1	PHOENIX ISLANDS	
Hatutu	2	Hull	1
Hita	2	Canton	1
Hivaoa	1	CHRISTMAS ISLAND	1
Nukuhiva	3	TONGA GROUP	
Roraka	4	Kelefesia	3
Taenga	1	Lalona	1
Tepoto	1	Teleketonga	1
Tiakara	2	SAMOAN ISLANDS	
Traita	1	Rose	2
Uapu	1	Tau	1
TUAMOTU ARCHIPELAGO		Ofu	1
Ahunui	2	FIJI ISLANDS	1
Ducie	5	NEW HEBRIDES	
Fakarava	1	Efate	1
Henderson	8	Banks	1
Hiti	1	Hiu	1
Manihi	2	Malekula	7
Maria	8	No data	8
Pitcairn	1		—
Tureia	1		97
SOCIETY ISLANDS			
Moorea	1		
Scilly atoll	1		
Tahiti	1		

TABLE II.—LOCALITIES OF *Rattus rattus alexandrinus* WITH NUMBER OF SPECIMEN COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

MARQUESAS ISLANDS	1	SOCIETY ISLANDS	
Hivaoa	1	Talati	1
Nukuhiva	1	Tahiti	2
Toau	1	Moorea	1
FIJI ISLANDS	1	Bow Bow	1
CAROLINE ISLANDS		No data	1
Kusaie	2		—
			13

TABLE III.—LOCALITIES OF *Rattus rattus rattus* WITH NUMBER OF SPECIMENS COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

SOCIETY ISLANDS		CAROLINE ISLANDS	
Moorea	1	Kusaie	1
			—
			2

TABLE IV.—LOCALITIES OF *Rattus norvegicus* WITH NUMBER OF SPECIMENS COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

SOCIETY ISLANDS		SAMOAN ISLANDS	
Tahiti	1	Tutuilla	3
Moorea	1	HORNE ISLANDS	
		Fotuna	1
			—
			6

TABLE V.—LOCALITIES OF *Mus musculus* WITH NUMBER OF SPECIMENS COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

SOCIETY ISLANDS		MARQUESAS ISLANDS	
Moorea	1	Hivaoa	1
TUAMOTU ARCHIPELAGO			—
Hiti	1		3

TABLE VI.—LOCALITIES OF *Rattus browni* WITH NUMBER OF SPECIMENS COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION

SOLOMON ISLANDS	
New Ireland	8 skins and skulls
	2 alcoholics (skulls extracted and cleaned)
NEW GUINEA	
Sevia	3 skins and skulls

TABLE VII.—MEASUREMENTS OF PACIFIC RATS, DERIVED FROM MATERIAL COLLECTED BY THE WHITNEY SOUTH SEA EXPEDITION, SUPPLEMENTED BY MEASUREMENTS PUBLISHED BY OTHER WRITERS

Locality	Name	Number	Sex	Head and Body	Tail	Hind Foot	Greatest Length of Skull	Zygomatic Breadth	Interorbital Breadth	Breadth of Rostrum Over Roots of Incisors	Mandible	Maxillary Tooth Row	Mandibular Tooth Row	Teeth Worn
TUAMOTU ARCHIPELAGO														
Henderson		A.M. 99790	♂				36.4	17.8	5.8	6.8	20.4	5.6	5.5	greatly
"		A.M. 99788	♂				35.2	18.0	5.6	6.7	20.9	5.5	5.7	greatly
"		A.M. 99782	♂					18.1	5.7	6.8	22.0	5.4	5.8	greatly
"		A.M. 99783	♂				35.5	16.8	5.3	6.5	20.6	5.3	5.4	moderately
"		A.M. 99781	♂				36.3	17.5	5.9	6.9	21.7	5.7	5.4	moderately
"		A.M. 99789	♂				36.4	17.7	5.4	6.7	21.8	5.2		greatly
"		A.M. 99772	♂				35.6	16.8	5.4	6.5	20.2	5.5	5.7	moderately
"		A.M. 99773	♀				35.4		5.5	6.4	20.2	5.4	5.4	greatly
Ducie		A.M. 99785	♂						5.2	6.1	18.6	5.4	5.4	moderately
"		A.M. 99791	♂				33.8	16.0	5.4	6.2	18.9	5.4	5.4	slightly
"		A.M. 99784	♂				33.9	16.0	5.3	6.3	18.9	5.3	5.4	slightly
"		A.M. 99770	♀				33.8	16.2	5.3	6.2	18.6	5.4	5.5	slightly
Pitcairn		A.M. 99771	♂				33.9	16.6	5.4	6.2	19.4	5.8	5.7	slightly
Maria		A.M. 99780	♂						5.3	6.1	20.1	5.4	5.3	moderately
"		A.M. 99775	♂						5.8	6.7	20.8	5.6	5.3	moderately
"		A.M. 99779	♂								20.5	5.8	5.6	moderately
"		A.M. 99713	♀				33.1	15.4	5.4	5.7	18.8	5.5	5.4	slightly
Manihi		A.M. 99715	♂						5.6	6.4	20.0	5.2	5.5	moderately
Apataki		A.M. 99703	♂					16.0	5.4	6.4	18.7	5.1	5.2	moderately

Fakarava		A.M. 99725	♂				35.2	16.2	5.4	6.3	20.0	5.4	5.3	greatly
Tepoto		A.M. 99704	♀				30.0	15.1	5.1	5.6	17.8	5.4	5.2	not
Hiti		A.M. 60645	♂					16.2	5.3	6.4	19.3	5.3	5.2	moderately
"		A.M. 99761	♀					15.3			18.7	5.3	5.3	moderately
Aratika		A.M. 99718	♂				34.2	16.1	5.7	6.1	19.7	5.2	4.5	moderately
Raraka		A.M. 99716	♂				33.4	16.1	5.6	6.3	18.7	5.4	5.3	slightly
"		A.M. 99763	♂				33.9	15.9	5.5	6.3	19.2	5.2	4.9	moderately
"		A.M. 99797	♂				34.4	16.1	5.3	6.5	19.3	5.4	5.3	moderately
"		A.M. 99764	♂				34.3	16.1	5.6	6.4	19.7	5.4	5.3	moderately
Ahunui		A.M. 99793	♂				33.7	15.7	5.4	6.1	19.3	5.4	5.3	moderately
"		A.M. 99794	♂				32.8		5.3	5.8	18.6	5.6	5.4	slightly
Tureia		A.M. 99792	♀					16.3	5.4	6.3	19.2	5.7	5.6	moderately
Pukapula (Dog)	[1]		♂	134.6	134.6	27.9								
Disappointment	[1]		♀	165.1	127.0									
AUSTRAL ISLANDS														
Rapa		A.M. 99796	♀				35.4	16.5	5.2	6.3	21.1	5.4	5.3	moderately
"		A.M. 48208	♀				32.4		5.2	5.4	18.6	5.9	5.8	slightly
Tubuai		A.M. 48206	♀				31.8	14.7	5.3	6.0	18.2	5.5	5.3	slightly
"		A.M. 48207	♀				33.5	15.1	5.4	5.6	18.8	5.8	5.5	slightly
Rapa		A.M. 99795	♂				38.0	17.7	5.7	7.1	22.6	5.9	6.1	moderately
SOCIETY ISLANDS														
Moorea		A.M. 60785	♂				34.5	16.9	5.5	6.2	19.9	5.5	5.5	moderately
"		A.M. 60643	♂				34.3		5.5	6.6	20.1	5.5	5.4	moderately
Tahiti		A.M. 48204	♀				33.1	15.2	5.2	5.8	19.1	5.5	5.3	slightly
"	[1]		♀	137.2	101.9	27.9								
MARQUESAS ISLANDS														
Uapu		A.M. 99721	♀				34.6	16.2	5.3	6.1	20.3	5.8	5.6	slightly
Hatutu		A.M. 99799	♂				32.9	15.6	5.1	6.0	19.0	5.5	5.4	moderately
"		A.M. 99717	♀				32.1	15.7	5.0	5.6	18.7	5.5	5.4	greatly
Fatuhuku		A.M. 99800	♂				33.3			5.9	19.2	5.2	4.9	greatly
Fatuhiva		A.M. 99720	♀				32.0	16.0	5.2	5.9	18.6	5.1	4.9	moderately
"Marquesas"		A.M. 63776	♂				33.0	15.6	5.2	5.9	19.3	5.4	5.1	moderately
Nukuhiva		A.M. 99722	♀					16.3	5.2	6.4	18.7	5.5	5.3	greatly
"		A.M. 63774					36.3	16.9	5.6	6.7	22.0	5.8	5.5	moderately

[1]From Peale (1848).

TABLE VII—(*Continued*)

Locality	Name	Number	Sex	Head and Body	Tail	Hind Foot	Greatest Length of Skull	Zygomatic Breadth	Interorbital Breadth	Breadth of Rostrum Over Roots of Incisors	Mandible	Maxillary Tooth Row	Mandibular Tooth Row	Teeth Worn
TONGA														
Kelefesia	[1]	A.M. 73624	♂	137.0[2]	125.0[2]	28.5	33.5		5.1	5.8	19.4	5.7	5.4	slightly
"		A.M. 77945	♂						5.0	6.0	18.9	5.8	5.5	slightly
"		A.M. 77944	♀						4.9	5.8	20.0	5.4	5.2	greatly
Teleketonga		A.M. 77946	♀				36.0	17.2	5.3	6.6	19.7	5.5	5.3	moderately
Lalona		A.M. 77947	♀				36.7	17.3	5.6	7.2	21.5	5.7	5.5	moderately
SAMOA														
Rose		A.M. 68747	♀				34.0	16.0	5.4	6.5	20.0	5.2	5.3	moderately
Ofu (Manua)		A.M. 68748	♀					15.0	4.9	5.8	18.4	5.3	5.2	slightly
Rose		A.M. 68742	♂				35.2	16.4	5.8	7.1	19.7	5.3	5.3	moderately
ELLICE														
Funafuti							35.0?	17.6	5.5			5.7	6.0	
"				125.0	148.0	28.0						6.2		
FIJI		A.M. 68764	♀				34.8	15.8	5.0	6.7	20.0	5.5	5.3	moderately
	[3]		♂	101.6	114.3									
	[3]		♀	78.7	85.4	22.8								
Ovalau	[4]			127.0	109.2				5.8		18.5			
PHOENIX		A.M. 68740	♀					16.6	5.3	6.1	19.2	5.4	5.5	moderately
Canton		A.M. 68741	♀				30.0	14.0	4.9	5.5	17.3	5.2	5.2	slightly
Hull	[3]			132.1	134.6	27.9								

[1]Dried skin and skull.
[2]Collector's measurements (originally taken roughly in inches).
[3]From Peale (1848).
[4]From Thomas (1880) (*Mus huegeli*).

CHRISTMAS ISLAND		A.M. 48212	♂				31.0	14.9	5.2	5.6	18.0	5.2	5.2	slightly
NEW HEBRIDES														
Malekula		A.M. 99755	♂				35.0	15.6	5.6	6.5	18.9	5.2	5.1	greatly
"		A.M. 99754	♂				34.8	16.3	5.4	6.3	19.5	5.3	5.5	moderately
"		A.M. 99760	♀					14.9	5.2	5.8	17.8	5.6	5.2	slightly
"		A.M. 99758	♀				32.9	15.3	5.3	6.1	17.7	5.0	5.0	greatly
"		A.M. 99757	♀				32.8				18.0	5.5	5.3	moderately
"		A.M. 99756	♀				30.0	14.2	5.1	5.6	16.8	5.0	5.1	not
"		A.M. 99759	♀					13.5	5.3	5.1	15.1	5.3	5.2	not
Torres (Hiu)		A.M. 79992	♂					15.8	5.3	6.2	19.1	5.2	5.2	moderately
Efate	[1]	A.M. 73623	♂	140.0[2]	130.0[2]	27.5			5.3	5.7	18.6	5.3	5.2	slightly
Tanna	[3]			148.0	136.0	27.0						6.0		
NEW CALEDONIA														
Ciu	[4]	1848	♂	140.	134.	25.5	34.0	16.5	5.5			5.5	5.3	
"	[4]	1849	♀	136.	140.	25.5								
LOYALTY														
Quépéncé	[4]	1854	♂	157.	151.	28.5								
KERMADEC ISLANDS														
Sunday	[5]						33.5		5.4					
"	[5]						33.5		5.5					
"	[5]						34.6		5.5					
"	[5]						34.7		5.5					
"	[5]						35.5		5.5					
"	[5]		♂	130–147	138–156	27–29								
				(136.5)	(148.0)	(28.1)								
"	[5]		♀	125–137	138–146	27–29								
				(129.5)	(143.9)	(27.8)								
NEW ZEALAND		[6]	♀	165.1	196.8	34.9								"adult"
		[7]					34.3	15.2						

[1]Dried skin and skull.
[2]Collector's measurements (rough).
[3]From Jentinck (1879).
[4]From Revilliod (1914).
[5]From Oliver (1911).
[6]From Buller (1871). *Mus novae zelandiae.*
[7]From Hutton (1887). "Picton" rats.

TABLE VII—(*Continued*)

Locality	Name	Number	Sex	Head and Body	Tail	Hind Foot	Greatest Length of Skull	Zygomatic Breadth	Interorbital Breadth	Breadth of Rostrum Over Roots of Incisors	Mandible	Maxillary Tooth Row	Mandibular Tooth Row	Teeth Worn
NEW ZEALAND		[3]	♂	158.7	142.6									
		[3]	♂	130.3	130.3									
		[3]	♀	101.6	127.0									
		[3]	♀	152.4	152.4									
MARSHALLS	[1]	2	♂	110.	155.	28.0	33.0	16.0	4.9	6.0		5.8		moderately
"	[1]	4	♂	102.	140.	26.0	30.0	14.0	4.6	5.3		5.2		slightly
"	[1]	7	♂	120.	145.	28.0	33.0	16.0	4.9	5.8		5.5		moderately
"	[1]	9	♂	75.	118.	25.0			4.4	5.4		5.2		slightly
"	[1]	10	♂	127.	156.	28.0	35.2	16.0	4.9	6.1		5.9		much
"	[1]	11	♂	105.		27.5		14.5	4.4	5.5		5.4		moderately
"	[1]	1	♀	110.	155.	28.0	33.0	16.0	4.9	6.0		5.8		moderately
"	[1]	13	♀	102.	132.	26.3	30.0	14.5	4.5	5.3		5.0		moderately
NORTH OF MARSHALLS														
Wake	[2]		♀	127.0	134.5	29.2								
EASTERN CAROLINES														
Yap	[1]	25	♂	125.	145.	26.0	36.0		5.4	6.3		5.5		moderately
"	[1]	27	♂	110.	147.	26.0	34.0	14.0	4.5	5.7		5.2		slightly
"	[1]	28	♂	107.	140.	25.5	33.5	14.0	4.5	5.0		5.0		slightly
"	[1]	29	♂	90.	120.	24.0	30.0	12.9	4.3	5.3		5.0		slightly
"	[1]	26	♂	110.	135.	25.0	32.5	15.0	4.7	6.0		5.1		much

[1]From Tokuda (1933).
[2]From Peale (1848).
[3]From White (1894). "Maori rat."

Palaus	[1]	33	♂	100.	115	24.0	30.2		4.3	5.5		5.1		moderately
"	[1]	32	♀	109.	122.	25.0		14.5	4.5	5.6		5.1		moderately
WESTERN CAROLINES														
Ponape	[1]	19	♀	110.	133.	25.0	31.5		4.6	5.5		5.2		moderately
HAWAIIAN														
Popoia	[2]	236896a	♂	135.	160.	27.5			5.0		18.8	5.2	5.0	moderately
"	[2]	236900	♂	133.	138.	27.0				5.6	18.2	5.2	5.0	moderately
"	[2]	236901	♂	127.	130.	25.0					17.4	4.8	4.8	moderately
"	[2]	9010b	♂	114.	111.	25.0	32.2	15.0	5.0	6.0	19.0	5.2	5.0	moderately
"	[2]	236897	♀	130.	130.	26.0	30.2		5.0		17.6	5.2	5.0	slightly
"	[2]	236898	♀	129.	140.	28.0	33.0	15.2	5.0	5.8	18.8	5.2	5.0	moderately
"	[2]	236899	♀	112.	125.	25.0	29.8	14.4	4.8	5.2	17.0	5.2	5.0	slightly
"		F:M. 24377	♂	135.	140.	28.0			5.2	5.7	17.2	5.1	4.9	
"		F:M. 24378	♂	137.	145.	29.0								
"		F:M.24376	♀	128.	140.	27.0		15.8	5.1	5.8	17.3	4.9	5.0	
Maui	[2]	9043					32.2	15.0	5.0	5.6	18.0	5.2	5.0	moderately
Kahoolawe	[2]	9025					33.4	15.6	5.0	6.0		5.4		much
"	[2]	9026					33.0	15.2	5.0	5.4		5.4		slightly
Maui		[3]257932	♂	133.	140.	25.	34.	16.2	5.3	6.1	19.	6.0	5.6	well
"		[3]257935	♂	140.	140.	25.	34.1	16.2	5.1		19.6	5.8	5.4	well
Oahu		[3]257952	♂	150.	137.	25–27	33.7	16.0	5.1	5.9	18.9	5.6	5.2	well
"		[3]257957	♂	148.	136.	25–27	34.1	16.6	5.0	6.3	18.8	6.1	5.2	well
HAWAII		[3]257937	♂	133.	153.	26.	34.5	16.7	5.1	6.4	20.4	5.8	5.5	much
"		[3]257941	♂	130.	150.	27.	33.5	16.8	5.1	6.0	19.7	5.8	5.2	well
Ocean Island		[3]243896	♂	120.	160.	30.	34.2	15.6	5.4	6.2	18.9	5.8	5.8	moderately
"		[3]243902	♂	120.	165.	29.	32.7	15.2	5.2	5.8	18.5	5.7	5.4	
Maui		[3]237930	♀	133.	140.	25.	32.8	16.2	4.9	5.5	18.8	5.9	5.3	well
Oahu		[3]257969	♀	150.	129.	25–27	32.6	15.7	5.3	6.1	18.7	5.6	5.2	well
Hawaii		[3]257940	♀	135.	152.	27.	33.1	16.4	5.2	6.0	19.2	5.7	5.5	well
Ocean		[3]243900	♀	123.	147.	27.		15.7	5.3	5.8	17.9	5.5	5.3	well

[1]From Tokuda (1933).
[2]From Miller (1924).
[3]U. S. N. M. series, collected by Dr. Eskey.

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