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ECTOPARASITES OF SOME POLYNESIAN AND MALAYSIAN RATS OF THE GENUS RATTUS

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A detailed account of the rediscovery of the Hawaiian rat was given in 1917 by Dr. Witmer Stone and Mr. John F. G. Stokes.[2] Doctor Stone described the animal as *Rattus hawaiiensis* but was unable to reach any conclusion regarding its systematic position in the genus Rattus. So far as I know there has been no further discussion of the subject in print. On August 22, 1920, I visited Popoia islet with Mr. Stokes in the hope of obtaining material which might enable me to make some definite comparisons of the Hawaiian rat with the Malayan and Philippine members of the group to which I supposed the species to belong. We arrived at Popoia before noon, and immediately put out a line of "out-o'-sight" mouse traps, chiefly along the borders of the milo scrub. These traps we visited every half hour during the rest of the day. No rats were taken until between 4 and 5 p. m., when the sky became overcast and the heat and light of the afternoon declined. The game then began to "bite," and six adult individuals were soon obtained. These six skins, together with that of the type, which is included in material lent to me by the Bishop Museum, show conclusively that *Rattus hawaiiensis* is a member of the *R. concolor* group, and furthermore that it is a very slightly differentiated form.

As a group, the *concolor* rats are well known and abundant throughout the Malay region from the Malay Peninsula and Sumatra eastward to Celebes and the Philippine Islands; evidence of a scanty nature has been found to show that they are also, or at least have been, widely dispersed over the islands of the Pacific. Though uniform in general appearance—superficially suggesting an enlarged housemouse—they show the same tendency to split up into many local races or species that is usual in all of the Muridæ of the Malay region. The characters by which these forms are distinguished from each other are not very conspicuous, consisting chiefly of slight differences in size and in exact shade of the general dull brownish color. Of the named members of the group the United States National Museum contains representatives of twenty-three. Two of these are the *Mus vitiensis* and *Mus exulans* of Peale, from Fiji and Tahiti respectively, the types and our only specimens of which are now in

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Stone, Witmer, The Hawaiian Rat; Stokes, J. F. G., Notes on the Hawaiian Rat: Bernice P. Bishop Mus., Occ. Papers, Vol. 3, No. 4, 1917.

such condition that the details of their characters can no longer be determind. A third member of the group is the Hawaiian rat.

At present the exact status of the named Malayan members of the *Rattus concolor* group is much in need of revision; it also appears probable that other races are yet to be discovered. Under these circumstances a comparison of *Rattus hawaiiensis* with the Malayan forms with a view to determining its nearest relationships and probable manner of origin cannot be entirely satisfactory. On comparing the Popoia skins with the large series of Malayan specimens in the National Museum it is at once seen that they are paler in color than typical *Rattus concolor* and other dark forms such as *R. querceti* or *R. buruensis*. The known Malayan race which they most nearly resemble is the *Rattus raveni raveni* Miller and Hollister of middle Celebes. Between this animal and *Rattus hawaiiensis* the agreement appears to be exceedingly close. I can detect no significant differences in measurements, either external or cranial. (See table, p. 5.) The skulls resemble each other in form with the unimportant exception that the rostrum in the Hawaiian specimens tends to appear slightly more robust when viewed from above. In color the Hawaiian skins, as a series, can be distinguished from the Celebesian specimens by the generally paler buff element, this especially evident on the under parts and on the sides of the body. In some individuals the chin and throat are almost white. An unsatisfactory feature of the material is the circumstance that the specimens prepared by Mr. Raven contain much less stuffing than mine; the skin is often marked by longitudinal creases produced during the process of drying, a condition which indicates general shrinkage of the skin and condensation of the pelage, with resulting darkening of the color. Hence the difference in the appearance of the two series, slight though it is, would have been still less if all the specimens had been prepared by one collector. On the basis of these comparisons the Hawaiian rat cannot be regarded as identical with any of the known Malayan or Philippine species. In the absence of knowledge concerning the color and cranial characters of the two described Pacific forms (*vitiensis* and *exulans* of Peale) it may be diagnosed as follows:

Characters.—A member of the *Rattus concolor* group closely resembling *Rattus raveni raveni* Miller and Hollister from middle Celebes, but differing from the Celebesian animal in an inconstant tendency toward a slightly more robust form to the rostral portion of the skull, and in the slightly paler, less yellow, buffy element in the general body color; chin and throat nearly white; sides of body and of head slightly more grayish than in *R. raveni raveni.*

TABLE OF MEASUREMENTS OF RATTUS HAWAIIENSIS AND RATTUS RAVENI

NAME AND LOCALITY		NUMBER	SEX	HEAD AND BODY	TAIL	HIND FOOT	GREATEST LENGTH OF SKULL	CONDYLOBASAL LENGTH	ZYGOMATIC BREADTH	INTERORBITAL BREADTH	NASAL	DIASTEMA	BREADTH OF ROSTRUM OVER ROOTS OF INCISORS	BREADTH OF BRAINCASE	DEPTH OF BRAINCASE	MANDIBLE	MAXILLARY TOOTHROW	MANDIBULAR TOOTHROW	TEETH WORN
R.																			
aiiensis.	Popoia	236896*a*	♂	135	160	27.5	.....	.....	.....	5.0	12.2	9.0	.....	.....	.....	18.8	5.2	5.0	Moderately
do	do	236897	♀	130	130	26	30.2	28.6	.....	5.0	.....	8.2	.....	13.2	8.6	17.6	5.2	5.0	Slightly
do	do	236898	♀	129	140	28	33.0	29.8	15.2	5.0	12.0	8.2	5.8	13.6	9.2	18.8	5.2	5.0	Moderately
do	do	236899	♀	112	125	25	29.8	27.2	14.4	4.8	11.0	8.0	5.2	13.0	9.2	17.0	5.2	5.0	Slightly
do	do	236900	♂	133	138	27	.....	.....	.....	5.0	12.2	8.4	5.6	13.8	9.0	18.2	5.2	5.0	Moderately
do	do	236901	♂	127	130	25	.....	.....	.....	.....	11.4	8.0	.....	13.2	8.8	17.4	4.8	4.8	Moderately
do	do	9010*b*	♂	114	111	25	32.2	30.4	15.0	5.0	12.2	9.0	6.0	14.0	9.4	19.0	5.2	5.0	Moderately
do	Maui	9043	....	.....	.....	.....	32.2	30.0	15.0	5.0	12.0	8.6	5.6	12.6	9.0	18.0	5.2	5.0	Moderately
do	Kahoolawe	9025	....	.....	.....	.....	33.4	31.2	15.6	5.0	12.6	9.4	6.0	13.6	9.8	.....	5.4	.....	Much
do	do	9026	...	.....	.....	.....	33.0	30.8	15.2	5.0	12.0	8.6	5.4	13.4	9.6	.....	5.4	.....	Slightly
aveni.	Celebes	199943	♂	110	140	26	31.2	28.8	14.6	4.8	11.0	8.0	5.2	13.2	9.0	17.8	5.0	5.0	Moderately
do	do	199946	♂	125	147	27	32.8	30.4	14.8	5.0	11.8	9.0	5.6	13.4	8.8	17.6	5.2	5.0	Moderately
do	do	200001	♂	118	150	25	32.0	29.4	14.6	5.0	11.8	8.0	5.4	13.0	8.6	16.8	5.2	5.0	Slightly
do	do	200004	♀	122	143	25	32.6	30.0	15.2	5.0	11.2	8.6	5.8	13.2	9.4	17.2	5.4	5.2	Much
do	do	200005	♂	124	140	25	31.6	29.4	14.0	4.8	11.2	8.2	5.6	13.0	9.4	16.4	5.0	5.0	Moderately
do	do	200009	♂	113	123	26	31.0	28.6	14.2	5.0	11.2	8.0	5.4	12.4	9.0	16.8	5.2	5.0	Moderately
do	do	200014	♂	118	135	26	32.8	30.0	14.4	5.0	12.4	8.4	5.4	13.4	8.8	17.4	5.4	5.0	Moderately
do	do	219693	♂	122	140	26	33.0	30.4	15.2	5.0	12.6	8.8	5.4	14.0	10.0	18.0	5.4	4.8	Much
do	do	219694	♂	130	125	25	32.4	30.0	.....	5.0	11.6	8.6	5.2	13.2	9.4	17.0	5.2	4.8	Moderately
do	do	219699	♂	110	123	25	30.4	28.2	14.0	4.6	11.2	8.0	5.4	13.4	9.2	16.2	5.2	4.6	Much

a Numbers above 100000 are those of the U. S. National Museum. *b* Type.

Present knowledge of the Hawaiian rat may be summarized as follows: (a) the animal discovered by Mr. Stokes and described by Doctor Stone is almost certainly the one which inhabited the Hawaiian islands at the time when they were first visited by the British; (b) this animal is a member of a well known and widely distributed Malayan group; (c) the characters which distinguish it from other members of this group, for instance, from *Rattus raveni* of Celebes, are of the same inconspicuous kind and slight degree as those which, within the boundaries of the Malay Archipelago, commonly distinguish races inhabiting adjacent islands or different parts of a single island. While I am now unable to identify the Hawaiian rat with any Malayan member of the *concolor* group it cannot be positively asserted that the animal is actually distinct from all of the less known Malayan races; the discovery of an exactly similar Malayan form would, in fact, cause no surprise. It is thus evident that there is no reason to suppose that the Hawaiian rat has inhabited the islands where it now occurs for a long period, geologically speaking, or

that its presence there is due to any other than human agency. In the city of Manila *Rattus querceti* Hollister, a member of the *concolor* group, occurs as a house rat. The ease with which the Hawaiian animal may be unintentionally transported by man is indicated by the note which Mr. Stokes[3] has published regarding the probable introduction from the mainland of Oahu of the rats now found on Popoia. According to this account the animals were carried out to the islet in the folds of a net by a native fisherman. Habitual tendencies on the part of members of the *concolor* group to associate with man are thus indicated. It seems probable, therefore, that *Rattus hawaiiensis* owes its presence in the Hawaiian islands to a process of gradual eastward dispersal from the Malay region out through the islands of the Pacific by way of native boats, at a date which cannot be supposed to have been very remote. Whether the animal has developed its supposed diagnostic characters since its arrival in Hawaii, or whether these characters are actually identical with those of the imperfectly known Fijian or Tahitian rats discovered by Peale, or with those of some named or unnamed Malayan form, are questions which cannot be answered now.

[3] Op. cit., p. 21.

ECTOPARASITES OF SOME POLYNESIAN AND MALAYSIAN RATS OF THE GENUS RATTUS

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Among the various lots of material sent to the United States National Museum in 1920 by the Bernice P. Bishop Museum for examination and study were several of ectoparasites from rats. These were collected from three localities as follows: Popoia Islet, Hawaii; Rosa Island, Samoa; and Fanning Island. In order properly to determine these parasites it became necessary for the writer to study those of related species of Rattus occurring on other islands of the Pacific. In doing so he soon sensed a problem in distribution and island species formation of considerable magnitude,—a problem the solution of which would require many years. This problem of the distribution of the ectoparasites, however, rests largely on the distribution of the parasite hosts. The distribution of the host species, fortunately, has already received attention. (See p. 3.)

The genus Rattus is a very ancient one, and the representatives found on the larger islands of Malaysia are for the most part supposed to be descendants of ancestral types which inhabited this region before these islands were separated from the continental mainland. The rats found on many of the smaller islands of the Pacific, including those found in Hawaii, were probably introduced by the native Polynesians when they colonized these islands. The species of the *concolor* group of the genus Rattus, according to Mr. Gerrit S. Miller, Jr., are very closely related but most of them are based on definite, non-intergrading characters.

The parasites obtained belong to five different species, two of them mites and three sucking lice.

One of the mite species obtained, *Laelaps echidninus* Berlese, is a cosmopolitan form that has been reported from many parts of the world on different rat species. This is the mite that transmits a fatal protozoan disease among domesticated white rats—a disease that is of little consequence among wild rats. This mite was taken from the following:

Rattus sp., Rosa Island, Samoa (Bernice P. Bishop Museum).

Rattus crassus ♂ (U. S. N. M. 145482), Pulo Lamukotan, Borneo.

The other mite taken belongs to the same genus as *echidninus,* but is a much smaller species which is not closely related. This mite was taken from the following hosts:

Rattus sp., Rosa Island, Samoa (Bernice P. Bishop Museum).

Rattus hawaiiensis, Popoia Islet, Hawaii (Bernice P. Bishop Museum). It is described as follows:

Laelaps hawaiiensis New species. (See fig. 7.)

A medium-sized, light brown species. Chelicerae when extended reaching beyond the palpi, chelae unequal and poorly chitinized. Body about two-thirds as broad as long and sparsely clothed with rather long spines. Sternal plate broader than long, anterior margin about straight, posterior margin broadly and evenly concave; anterior sternal spines situated directly on the anterior margin of sternal plate, middle sternal spines situated outside of lines drawn from anterior to posterior spines, posterior sternal spines situated inside of both posterior and lateral margins of sternal plate; all sternal spines subequal. Ventral abdominal plate broader than anal plate and equal to the sternum in width. It is truncate behind and bears four pairs of lateral, marginal, subequal spines. Anal plate subtriangular with almost equal sides; anal opening longer than broad and situated about two-thirds its greatest diameter from the anterior margin of anal plate; paired anal setae smaller than median anal seta and situated at the level of the posterior margin of the anus; median anal seta situated at the tip of anal plate. Legs short and stout; first and second pairs of equal stoutness, but first pair slightly longer than second; third and fourth pairs of legs equally stout but the fourth pair the longer. Length, 0.59 mm.; width, 0.36 mm.

Type host and type locality: *Rattus hawaiiensis,* Popoia Islet, Oahu island, Hawaii.

Type material: several specimens, Bernice P. Bishop Museum.

The description is based on female specimens in the type lot. A male found in this lot has the chelicerae like those of the genus Liponyssus and may not belong to this species.

The three species of sucking lice found, to which should be added one previously reported by Ferris from Lankavi Island, Malay Straits, are as follows:

Polyplax n. sp.

Hoplopleura, two n. sp.

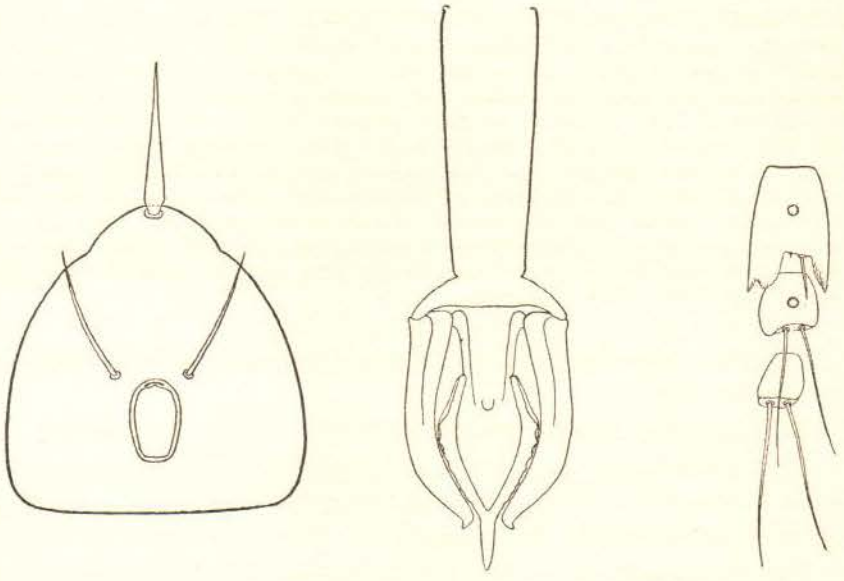
Hoplopleura malaysiana Ferris.

Rats, not only of the genus Rattus but of other genera, are commonly parasitized by two groups of sucking lice represented by the comprehensive genera Polyplax and Hoplopleura. Both of these genera are very large and their species are found on Murid hosts from nearly all parts of the world. The single Polyplax species taken was obtained from a skin of *Rattus surdus* collected in West Sumatra, and now in the United States National Museum.

Of the Hoplopleura species, *H. malaysiana* Ferris had been described by Ferris (1921) from *Rattus vociferans lancavensis* taken at Lankavi

Island, Malay Straits. A paratype of this species, which was taken from a skin in the United States National Museum, has been examined by the writer. It is a rather unusual species in that it lacks the lateral lobes and large divergent spines on the articulating sternal plate of the third abdominal segment. Only a single record exists for this species.

One of the other species of Hoplopleura was obtained only from *Rattus chalcis* (U. S. N. M. 145778) collected at Baguio, Luzon, Philip-



a *b* *c*

FIGURE 1.—*a*, Anal plate of *Laelaps hawaiiensis*, new species; *b*, dorsal view of genital armature of male of *Hoplopleura pacifica*, new species; *c*, dorsal view of last three pleural plates of left side of abdomen of female of *Holopleura pacifica*, new species.

pine Islands. This species is related to the very cosmopolitan *H. affinis* (Burm.). It will be described in a more comprehensive paper to be published by the United States National Museum.

The remaining speceis of Hoplopleura, also new, was found on several Rattus species. It is described as follows:

Hoplopleura pacifica New species. (See fig. 1.)

Female.—First segment of antenna as broad as long; second segment enlarged distally, considerably longer than first segment and much longer than broad. Large dorsal seta of head about as long as head is wide and just inside of this large

pair of setae is a minute pair, each member of which is situated slightly less than its length directly inward from the large seta. Typical pleural plates of abdomen large, longer than broad and with large posterior lobes flanking deep squarish emargination. Each of posterior lobes of typical pleural plates with concave posterior emargination and serrate edges; outer corners of lobes acute, inner rounded. Dorsal seta of each typical pleural plate, very minute; ventral seta conspicuous, about as long as the posterior lobes themeslves. Pleural plate I over half as long as II; II with subequal, slightly curved posterior lobes and with setae considerably exceeding lobes; III similar to typical pleural plates, but narrower and with shallower posterior squarish emargination and with both setae longer than posterior

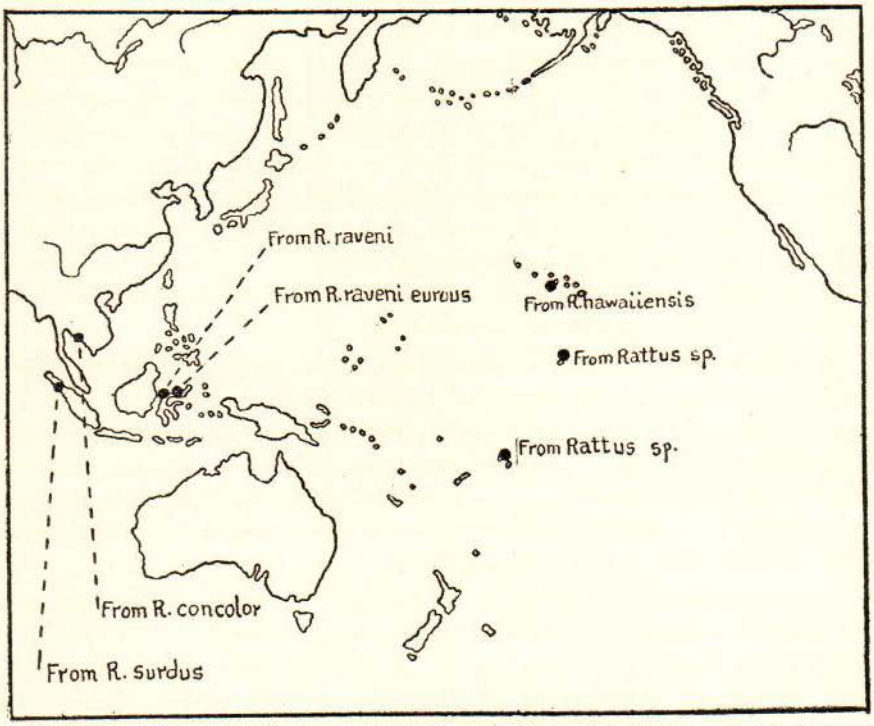


FIGURE 2.—Map showing geographical and host distribution of *Hoplopleura pacifica,* new species. Large dots indicate locality records.

lobes and subequal; V-VI, typical; VII without ventral posterior lobe and with only a slight development of dorsal posterior lobe, plate about as long as broad with centrally placed, large spiracular opening and with two long, subequal setae about twice as long as the plate itself; VIII smaller than VII and without a vestige of either posterior lobe, longer than broad, without spiracular opening and with two long, subequal setae, slightly exceeding those of VII in length. Sternum with long posterior extension, the sides of which are divergent. Length, 1.20 mm.; width, 0.45 mm.

Male.—Basal plate of genital armature very long and with sides almost parallel; at the distal end the basal plate expands into a broad Y. Parameres stout, long, curved and each ending in a stumpy, outwardly curved hook. Dilator with endo-

meres articulating proximally with bases of parameres, and with teleomeres united distally and continued as a spine-like pseudopenis. Outer margin of teleomeres irregularly serrate. Length of male, 0.87 mm.; width, 0.38 mm.

Type host and type locality: *Rattus hawaiiensis,* Hawaiian islands.

Type material: a slide of specimens, Bernice P. Bishop Museum.

Description based on type material consisting of seven females and five males.

The distribution of *Hoplopleura pacifica,* new species, is indicated in figure 2. It was found to occur on at least six different forms of the genus Rattus and possibly seven. Some of these hosts, particularly *R. concolor, R. raveni, R. raveni eurous* and *R. hawaiiensis* are said to be very closely related, yet by mammalogists are considered distinct. A large series of louse individuals and lots were obtained. At first it appeared that some of these lots represented distinct varieties, particularly did those taken from *R. raveni* appear to differ from the others in regard to the detail of the male genital armature. However, a study of a larger series from other hosts showed that these differences fell easily within the range of individual variation.

The occurrence then of a single louse form on these different Rattus species over such a wide range of isolated localities illustrates well Kellogg's principle in regard to the occurrence of the same parasite species on different and widely separated host species, that is, in such cases the species should be considered as one handed down unchanged to the present specifically distinct host species from the ancestral type from which these distinct host species were evolved.

As an explanatory hypothesis for the lack of specific differentiation of the parasite species in such cases, it is here suggested, with particular reference to *Hoplopleura pacifica* and its Rattus hosts, that a great similarity in the fur environment of the different host species, coupled with a remarkable stability of the germ plasm in the particular strain of parasites involved, have been chiefly responsible for the conditions obtaining.