ATOLL RESEARCH BULLETIN

NO. 446

# DISTRIBUTION OF RAT SPECIES (*RATTUS* SPP.) ON THE ATOLLS OF THE MARSHALL ISLANDS: PAST AND PRESENT DISPERSAL

BY

D.H.R. SPENNEMANN

ISSUED BY
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
OCTOBER 1997

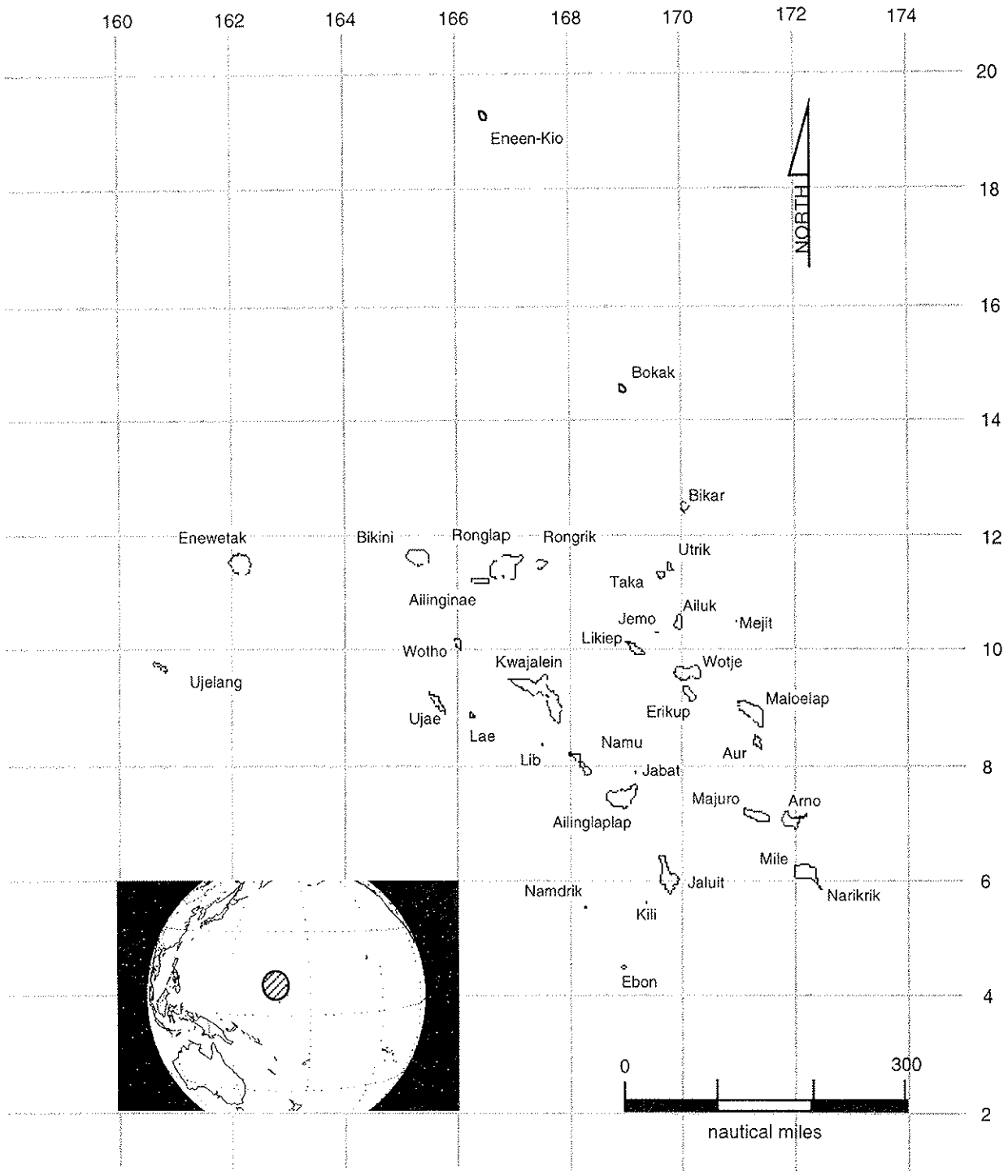


*Figure 1 Index map of the Marshall Islands showing the atolls mentioned in the text.*

# DISTRIBUTION OF RAT SPECIES (*RATTUS* SPP.) ON THE ATOLLS OF THE MARSHALL ISLANDS: PAST AND PRESENT DISPERSAL

by

Dirk H.R. Spennemann[¶]

## INTRODUCTION

The study of dispersal processes of small mammals, and especially of rodents, has a wide range of applications and until recent years there were few publications discussing the colonisation of 'oceanic' islands by small mammals (cf. Crowell, 1986; Diamond, 1987; Hanski, 1986; Heany, 1986; Lomolino, 1986).

This essay will be concerned with the distribution of rat species in the Marshall Islands and its implications on the interpretation of the settlement and human use of the atolls. It will be argued that in all instances the introduction of rats was caused by people and that accidental transport, such as rafting on drift wood and the like, is as unlikely as introduction by means of ship wrecks. Human transport as well as the rats' own inability to cross great distances of water makes them bad zoogeographical markers, as already pointed out by Braestrup (1956), but it is precisely this trait that is of concern here. This paper will argue that the Polynesian rat (Rattus exulans) was an intentional introduction to the area and that its distribution throughout the Marshall Islands was a deliberate strategy.

## THE MARSHALL ISLANDS

The Marshall Islands (*Aeon Kein Ad*), comprising 29 atolls and 5 islands, are located in the northwest equatorial Pacific, about 3790km west of Honolulu, about 2700km north of Fiji and 1500km east of Ponape. With the exception of the two northwestern atolls, Enewetak and Ujelang, the Marshall Islands are arranged in two island chains running roughly NNW to SSE: the western Ralik Chain and the eastern Ratak Chain (figure 1). Not counting the five islands, Jemo, Jabwat, Kili, Lib and Mejit, the atolls of the Marshall Islands range from very small, with less than 3.5km$^2$, such as Nadikdik (Knox) Atoll, to very large. With 2173km$^2$ lagoonal area, Kwajalein Atoll has the distinction to be the atoll with the World's largest lagoon. Distances between neighbouring atolls range from as little as 7nm (as in the case of Nadikidik and Mile) to over 400nm.

There is a range of rainfall regimes, ranging from almost 4000mm yr$^{-1}$ as measured on the southern atoll of Jaluit (5°47'N) to 1000mm yr$^{-1}$ as noted for the northern atoll of Wake (19°28'N). Concomitant with that comes a range of vegetation patterns with drier ecotones prevailing in the north. The lack of a permanent ground water lens (Ghyben-Herzberg lens)

¶ The Johnstone Centre, Charles Sturt University, PO Box 789, Albury NSW 2640, Australia.
e-mail: dspennemann@csu.edu.au.

**Manuscript received 27 June 1997; revised 4 September 1997**

makes these atolls very marginal for human habitation. It is thus not surprising that these islands have been recorded as uninhabited in the past (cf. Spennemann, 1992). The question arises whether these islands were ever visited by the Marshallese, either on a temporary of a semi-permanent basis.

## THE RAT SPECIES

Today, there are three rat species present in the Marshall Islands (table 1): the Polynesian rat (*Rattus exulans*), the European rat (*Rattus rattus,* 'black rat'), and the Norway rat (*Rattus norvegicus*). In addition, the house mouse (*Mus musculus*) is reputedly present on Majuro, Enewetak and possibly Kwajalein Atolls (Berry & Jackson, 1979). The pre-World War II rat population of the Marshall Islands, it seems, did not comprise *Rattus rattus* or *R. norvegicus*. Before we review the historic evidence, let us look at the dispersal mechanisms used by rats.

The Polynesian rat is a fairly sedentary animal with a limited home-range. Contrary to black rats (*Rattus rattus*), the Polynesian rat was not observed marking its territories (Tomich, 1970). It has a predominantly herbivorous diet (Bettesworth, 1972; Fall *et al.*, 1971) but has also been observed predating on insects (Harrison, 1954; Fall *et al*, 1971), snails (Harrison, 1961), land crabs (Moseby *et al.*, 1973), lizards (Crook, 1973; Whitaker, 1973), turtle hatchlings (Balazas, 1983; Hoeck, 1984, p. 242), and bird eggs (Atkinson, 1978; Bourne, 1981; Norman, 1975).

While Polynesian rats can be a plague on European-style monoculture plantations (Bianchi & Smythe, 1965; Bonin, 1982, 1986; Canter Visscher, 1957; Friend, 1971; Halafihi, 1985; Pierce, 1971a, 1971b; Twibell, 1973; Williams, 1974, 1975, 1982; Williams & Misikini, 1972; Wodzicki, 1969), they were little problem in the horticultural framework of the Marshallese culture. Indeed, Chamisso (1986) mentions that the number of rats had already increased in the period between his first (1816) and second visit (1817) to Wotje Atoll, destroying most of the plants planted in a model garden. Thus it was decided to leave behind a number of cats.

It has been put forward that *Rattus exulans* is responsible for the decline of the lizard fauna in New Zealand and beyond (Crook, 1973; Morrison, 1954, p. 4; Whitaker, 1973, 1978). Elsewhere it had been argued (Spennemann, 1989, p. 142) that this fact might explain the observed extinction of large lizard species after initial human settlement of oceanic islands (Poulsen, 1987; Pregill & Dye, 1989).

Traditionally, that is before the arrival of the first European visitors, the 'bird atolls' of Jemo, Taka, Bikar and Bokak had been regarded as refuges where the taking of birds and eggs has been tightly regulated by custom (Erdland, 1914; Fosberg, 1957; Tobin, 1952). The fact that the bird populations continue to thrive (Amerson, 1969; Thomas, 1989) may indicate that the presence of *Rattus exulans* is not detrimental to the overall bird population.

Both *R.rattus* and *R.norvegicus* are omnivorous and take whatever food is available. In addition, both species are on the whole substantially more carnivorous than *R. exulans* and have been shown to prey not only on insects, but also on bird eggs, bird fledglings, lizards,

land snails, molluscs, turtle hatchlings, and land crabs (Atkinson, 1978; Austin, 1948; Bailey & Sorensen, 1962; Bettesworth & Anderson, 1972; Crook, 1973; Daniel, 1973; Fall *et al.*, 1971; Harrison, 1961; Ramsay, 1978; Swink *et al.*, 1970; Watts & Aslin, 1982; Whitaker, 1973, 1978). The two larger species are also known to displace *R.exulans* from their environmental niche (Atkinson, 1973). Once established the rats have been shown to be quite resilient against natural disasters, being able to survive at least short-time flooding of an island by storm surges (as evidenced by the tidal surge generated by the Enewetak nuclear tests; Jackson, 1969).

A local example of the impact of introduced rats comes from Wake Atoll (Eneen-Kio), where the most dominant mammal on the atoll was the Polynesian rat. During the Japanese period of occupation in World War II the *R. rattus* was introduced (Bryan, 1959). The original bird life consisted of about a dozen different species of sedentary sea birds, and a few species of migratory sea birds. The only nonmigratory land bird native to and only occurring on Wake was the flightless rail, *Rallus wakensis*, which was still seen by the Tanager expedition in 1922, but which is now presumed to be extinct (Bryan, 1959). Given the introduction of shipborne rats in Japanese times an eradication of the rail by predatory rats possibly couped with human predation appears to be the most likely explanation of its extinction.

## DISPERSAL OF RATS

The dispersal of small mammals over greater and smaller expanses of water is thought to have happened in three basic ways:

i) by accidental rafting on material floating in the water (such as tree trunks, logs, islands of vegetation, and other debris);

ii) by swimming; and finally

iii) by human-induced transport on boats, ships and rafts.

In the cold climates of the high latitudes movement over frozen lakes and the like, as well as rafting on ice floats, is also possible (cf. Lomolino, 1986). Accidental rafting on debris depends entirely on the direction of wind and surface currents and can thus be assessed by the means of computer simulation studies (cf. Ward *et al.* 1973) as well as a review of documented drift voyages. In the Marshall Islands drift has been documented for the following places of origin: California, North America; Central Solomons; Japan; various atolls in central Kiribati; Krakatau, Indonesia; Maui, Hawaii; Palmyra Atoll, Line Islands, Kiribati; Philippines (?); Tuluman I., Bismarck Archipelago, PNG; and Lamotrek, Pingelap, Woleai and Yap in the Carolines, Federated States of Micronesia (Spennemann, 1996; in press). Internal drift has been documented for the Ratak atolls Mile and Mejit, in both cases reaching atolls in the Ralik Chain.

Dispersal of small terrestrial animals over long stretches of open water is impeded and rats have been shown to be unable to cover distances in excess of 2km on their own account (Jackson & Strecker, 1962; Spennemann & Rapp, 1987, 1989). Survival on drifting items over prolonged periods of time is also unlikely due to prolonged exposure to the tropical sun coupled with a lack of water and food. Another argument against successful large-scale

accidental dispersal of Polynesian rats on drift wood is the lack of this species on Johnston Atoll (Amerson & Skelton, 1976) and the French Frigate Shoals (Amerson, 1971), places which are not known to have had pre-European settlement at any time.

Thus, rats occurring on an isolated atoll are very likely to have been introduced at one point in time by people either intentionally or accidentally as stowaways. This has also been assumed previously by some authors (cf. Tate, 1935; Luomala, 1975). Parr (1941, p. 95) comments that the Polynesian rats on Wake Island were likely to come from wrecks or from "Polynesian" canoes. Unlike *R.rattus* and *R.norvegicus,* which are both known to be shipboard rats and thus could be accidental European or Asiatic import during the last two centuries, Polynesian rats are not known to infest vessels.

## RATS AS A FOOD SOURCE

An unintentional human introduction of rats to the Marshall Islands is very unlikely, given the size of Marshallese voyaging canoes which were commonly about 18 to 20m long (exceptionally up to 30m) and had rather narrow hulls (Alessio, 1990; Browning, 1972; Chamisso, 1910, 1986; Erdland, 1914; Finsch, 1887; Hambruch, 1912; Hernsheim, 1887; Krämer, 1905; Krämer & Nevermann, 1938). Given that size, then, rats would have been noticed if present. Rather, it would appear, rats were a welcomed source of food which – once released – could fend for itself and thus were taken along as deliberate introductions.

The Polynesian rat is believed to have originated in the Malayan region (Tate, 1935; Musser & Newcomb, 1983; Roberts, 1991), to have been spread by native canoes, and to have been deliberately introduced to many islands by Polynesians who considered it a valuable food source. There is archaeological evidence for pre-European distribution of *Rattus exulans* on other atolls and islands in the Pacific, such as Nukuoro (Davidson, 1971); Kapingamarangi (Leach & Ward, 1981); Tikopia (Kirch & Yen, 1982, p. 277); Kiribati (Luomala, 1975), 'Eua, Tonga (Spennemann, 1987); Ha'apai, Tonga (Dye, 1987; Spennemann, 1988); Tongatapu, Tonga (Poulsen, 1987); Niuatoputapu, Tonga (Kirch, 1988); and Easter Island (G.Clark pers.comm.).

In Tonga, Polynesian rats have been part of the diet (Gifford, 1929, p. 339; Martin, 1817, p. 279) and hunted for food and for entertainment (Martin, 1817, p. 279-283; Vason, 1810, p. 102-103). Polynesian rats have been seen on numerous now uninhabited islands, which have later on proven to have carried human occupation, eg. Henderson I. (Schubel & Steadman, 1989; Sinoto, 1983; Tate, 1935). In the Marshall Islands rats were eaten mainly by women. Chamisso, for example, observed rats being eaten on Wotje and Uterik in 1816/1817 (Chamisso, 1910, p. 169). Eating rats was common among several Pacific cultures where pigs (if present) and chicken were reserved for feasts and where terrestrial animal protein was rare. Eating rats, the only ubiquitous animals around, appears to have been a convenient means to provide protein for pregnant and lactating women.

## DISTRIBUTION OF RATS IN THE MARSHALL ISLANDS

Overall the historic documentation of the rats is limited as they were never the focus of detailed study until after World War II.

*Rattus exulans* was observed on Wake (Eneen-Kio) possibly as early as 1568 is the identification of Wake or Bokak with Alvarez de Mendaña's San Francesco Island is correct (cf. Hezel, 1983, p. 29; Werstein, 1964, p. 13). *Rattus exulans* was also observed by the Russian Exploring Expedition of 1816/17 on Maloelap (Kaven), Wotje and Uterik (Chamisso, 1910, p. 169, 1986; p. 156). Chamisso comments that some informants claimed that the rat was nonexistent on Bikar Atoll. This should be read *cum grano salis* as Chamisso's informants' knowledge on the peripheral atolls was very limited at best, not very surprising in view of that fact that he was not a Marshallese but came from an atoll in the Western Carolines. It is of significance, however, that in Chamisso's opinion his informant Kadu could only think of the rats as a companion to people (Chamisso, 1910, p. 169).

Chamisso (1986, p. 156, 196) mentions that the number of rats had already increased in the period between his first (1816) and second visit (1817) to Wotje Atoll, destroying most of the plants he had planted in a model garden. Cats were released to act as vermin control, but by 1830, when Kotzebue returned to Wotje, the number had not diminished (Kotzebue, 1830, p. I 308).

The U.S.Exploring Expedition saw Polynesian rats in 1840 on then uninhabited Wake Island and collected some specimens (Cassin, 1858; Peale, 1848; Pickering, 1879; Poole & Schantz, 1942). The Tanager expedition in 1922 recorded only *Rattus exulans* for Wake (Picking, 1922), where they appear to have occurred in reasonable numbers. Following the establishment of the Pan American Airways station on Wake and the creation of open rubbish tips, Polynesian rats were to become a plague of major proportions and eventually were the focus of several eradication campaigns (Anonymous, 1941; Bryan, 1959; Devereux, 1947; Foulton, 1939; Grooch, 1936; Miller, 1936).

In the late 1880s, with the beginning of the German colonial administration, the number of scientific studies increased, mainly focussing on the avifauna, as rodents were seen as a pest (Anonymous, 1895) and not the focus of enquiry. As a side-effect of increased copra production the number of rats increased too. The German district Officer Georg Merz, stopping at Majuro Atoll in 1910 on occasion of his annual inspection voyage, reports on large numbers of rats in plague proportions and suggest the release of cats to reduce the rat problem (Merz 1910). The data in hand suggest that the pre-World War II rat population of the Marshall Islands comprised neither *Rattus rattus* or *R. norvegicus*, with the possible exception of Jaluit and Majuro Atolls, the former the administrative centre of the German and (later) Japanese Colonial Administrations, and the latter an atoll with a well established trading station replete with pier.

## INTRODUCTION OF RATS, 1885 TO PRESENT

Inter-atoll communication in the Marshall Islands was previously upheld solely by the means of local canoe transport. Local communication between the atolls, however, seems to have been largely restricted to the southern part of both the Ralik and the Ratak chains, and between the southern parts and northern parts of either chain. An investigation of the distribution of introduced epidemics clearly documents this pattern. For example, Steinbach (1893), discussing the spread of a syphilis epidemic, mentions that it was prevalent in Majuro, Ebon and Jaluit Atolls but occured only in limited proportions in the northern atolls, which had little communication with the former.

With the increasing presence of European traders, however, European vessels and even ship-/boat-building of European-type vessels, built by J.de Brum on Likiep Atoll, became more common. Conversely, the inter-atoll transport was increasingly conducted with larger, European-type vessels (*cf.* Linckens, 1912). During the period of the German colony, the Jaluit Gesellschaft operated a steam vessel as well as a number of sailing schooners in the islands. Further transport was provided by a vessel of the Australian Trading Company Burns Philp and Co. Apart from the inter-atoll trade, the Jaluit Gesellschaft also operated "long-distance" voyages to Pohnpei, Palau and New Guinea, In addition, there were the regular annual visits of German naval vessels. With the exception of Jaluit and Majuro none of the atolls had proper landing bridges or piers during the German period, and thus all vessels had to anchor in the lagoon with all trade being conducted by launch or canoe. The same applies to the few whalers that came in the 1880s to replenish their stores of water and food (Langdon, 1978, 1979).

Such conditions, however, are not at all conducive to the introduction of shipboard rats. The same pattern continued during the Japanese period until in the late, 1930 piers were built on islands earmarked for future military development (Yanaihara, 1940; Japanese Government, 1929).

The German government introduced quantities of soil to Jaluit to run the experimental garden. The import occurred mainly in the form of ship's ballast, brought by copra trading vessels returning partially empty from the volcanic high islands in the Carolines (such as Ponape) (cf. Anonymous, 1895; Fosberg, 1961; Fosberg & Sachet, 1962, p. 1; Stevenson, 1914, p. 150). It is possible that rats were also 'landed' during the unloading of these vessels.

The Japanese have a history of both unintentional and intentional introductions: during the period of Japanese administration import of soil directly from Japan has been reported (Price, 1935, p. 256). The Japanese, intent on staying for a long time, imported night soil from Japan to improve the soil on both Wake and Wotje Atolls (Kephardt, 1950, p. 34). Import of the same material can be assumed for two, or three other major Japanese bases, namely Kwajalein/Roi-Namur, Taroa (Maloelap Atoll) and Jaluit, all of which had been built before the begin of the Pacific War. These soil imports are likely to have been very small, just confined to gardening plots.

*Table 1. The occurence of Varanus indicus and the distribution of rodent species on the atolls of the Marshall Islands. [1]*

| Atoll | *Rattus exulans* | *Rattus rattus* | *Rattus norvegicus* | *Mus musculus* | Japanese Development | *Varanus indicus* |
|---|---|---|---|---|---|---|
| Ailinginae | ■ | | | | | |
| Ailinglaplap | ? | | | | | |
| Ailuk | ■ | | | | | |
| Arno | ■ | ■ | | | | |
| Aur | ? | | | | | |
| Bikar | ■ | | | | | |
| Bikini | ■ | | | | | |
| Ebon | ? | | | | | |
| Eneen-Kio [2] | ■ | ■ | | | major | |
| Enewetak | ■ | ■ [3] | | ■ | major | Present |
| Erikup | ■ | | | | | |
| Jabwat | ■ | | | | | |
| Jaluit | ■ | ■ | ■ | ■ | major | |
| Jamo | ■ | | | | | |
| Kili | ? | | | | | |
| Kwajalein | ■ | ■ | | | major | Eradicated |
| Lae | ■ | | | | | |
| Lib | ■ | | | | | |
| Likiep | ■ | | | | | |
| Majuro | ■ | ■ | ■ | ■ | major | Eradicated |
| Maloelap | ■ | ■ | | | major | |
| Mejit | ■ | | | | | |
| Milli | ■ | ■ | | | major | |
| Nadikdik | | | | | | |
| Namorik | ■ | | | | | |
| Namu | ■ | | | | | |
| Rongelap | ■ | | | | | |
| Rongerik | ■ | | | | | |
| Taka | ■ | | | | | |
| Taongi | ■ | | | | | |
| Ujae | ■ | | | | | |
| Ujelang | ■ | | | | | |
| Utirik | ■ | | | | | |
| Wotho | ■ | | | | | |
| Wotje | ■ | ■ [4] | | | major | Eradicated (?) |

[1] Compiled after Berry & Jackson 1970; Betlack & Eckhardt 1945; Bryan 1959; Cassin 1858; Chamisso 1986; Finsch 1893; Fosberg 1955, 1956; 1957, 1990; Gressitt 1961; Hatheway 1953; Kotzebue 1830; Marshall 1950; 1957; Thomas 1989; and own observations. [2] Wake Atoll in US parlance. [3] Introduced by the U.S. forces after 1944. [4] Introduced by the Japanese in the 1930s.

Apart from introducing plant pests along with the soil, the Brahminy blind snake (*Ramhotyphlos brahmina*, TYPHLOPIDAE) seems to have been introduced, occurring so far only on Enewetak Atoll (but there on different islands). The secretive, nocturnal and earth burrowing nature of this harmless snake makes its discovery a difficult (Lamberson, 1987).

During the Japanese occupation of Wake in World War II (Dec.1941–Sept.1945), *Rattus rattus* was introduced with devastating effects on the birdlife (Fosberg, 1959). Cunningham (1961, p. 87), Commanding Officer of the Wake I. garrison and commenting on the events of December 1941, mentions "*Wake Island's stunted rats*", which seems to refer to the Polynesian rat, suggesting that the black rat and the Norway rat had not yet arrived.

As these rats were present after the war, their import must have occurred during Japanese times. Already in the 1930s the Japanese had introduced the brown rat to Wotje (Marshall, 1950, p. 23) and Jaluit. While Marshall suggests that *R. rattus* may have been also introduced to Arno before the war, it is more likely that the landing boat activity of U.S. forces during the relocation of Marshallese from various Japanese-held atolls via Majuro to Tutu Island on Arno Atoll (Richard, 1957), is responsible for its introduction. The distribution of rat species in the Marshalls (table 1) shows that *R. rattus* and *R.norvegicus* are present on those atolls that were major Japanese military installations during World War II.

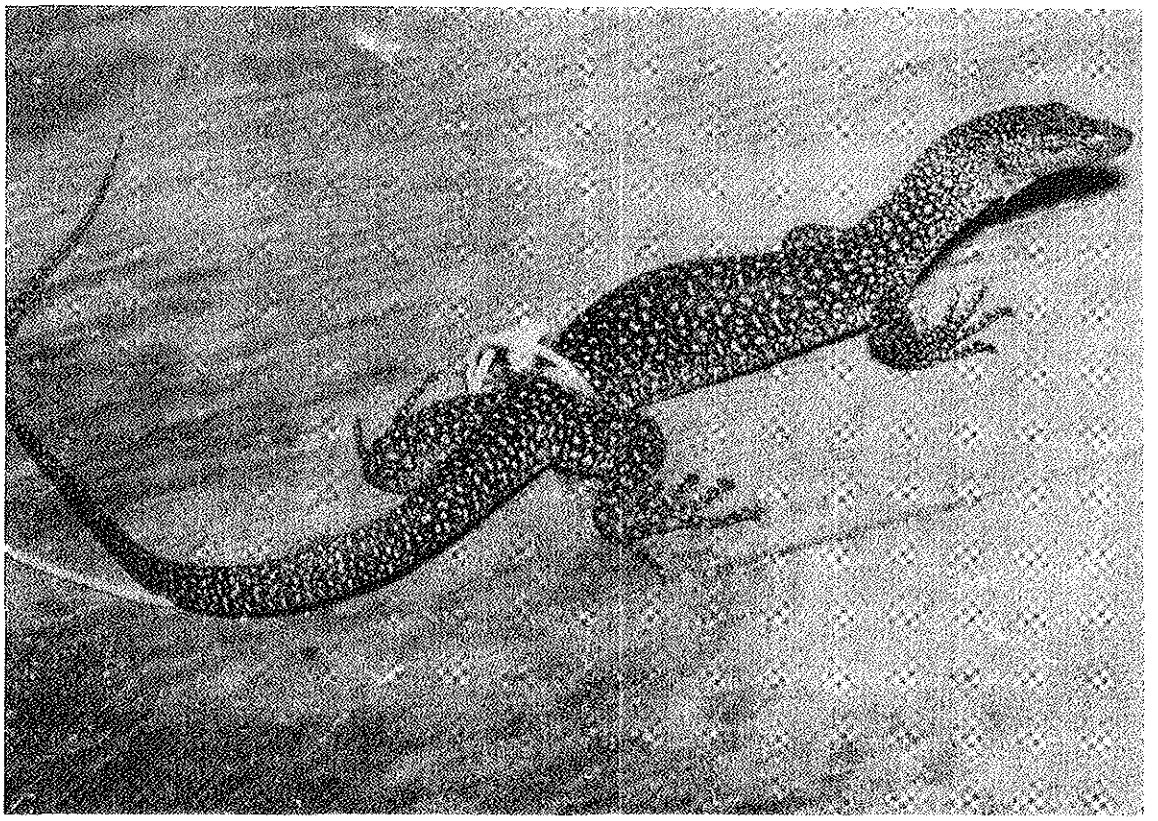

*Figure 1. A specimen of* Varanus indicus *caught on Majuro Atoll, Marshall Islands during 1944/1945 (after Betlack & Eckhardt 1945).*

The rat problem on some bases reached such proportions that *Varanus indicus* were introduced to prey upon the rats. Instead, according to local Marshallese informants, the reptiles predated on the chickens as well as other birdlife. *Varanus indicus* has been described for Enewetak (Lamberson, 1987), where an extensive natural history assessment has been carried out. Immediately after the Pacific War it was found on Majuro when the US forces occupied the atoll (Betlack & Eckhardt, 1945). Today, *Varanus indicus* is occasionally caught on Enewetak and brought to the population centres of Majuro and Enewetak as a pet (pers. obs.).

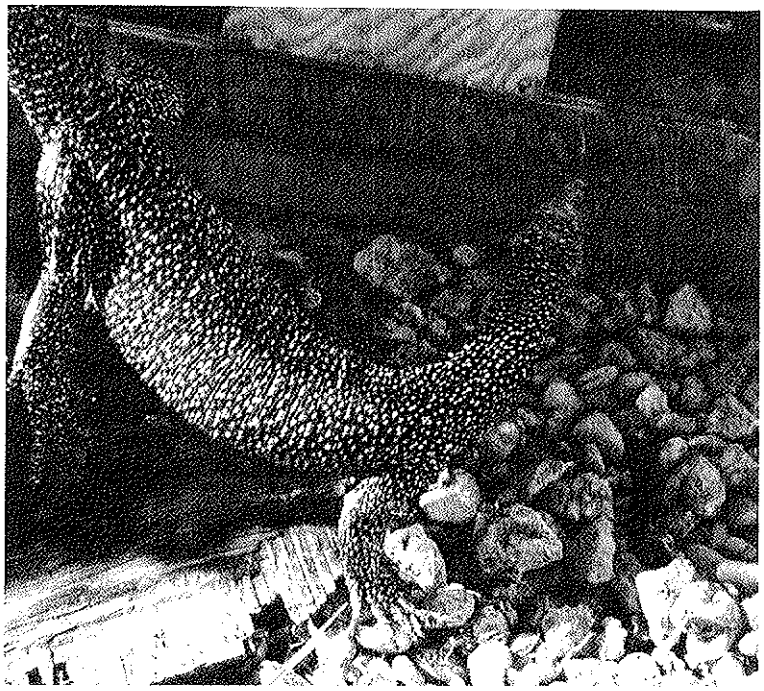

*Figure 2. A specimen of* Varanus indicus *caught on Enewetak Atoll and brought as a pet to Majuro Atoll, Marshall Islands (November 1992).*

The distribution of the rat species in 1991/92, as shown in table 1, is based on a literature survey, as well as my own observations. The lack of *R.rattus/R.norvegicus* on most atolls is confirmed by own and other observations. Even though no trapping was carried out where *R.rattus/R.norvegicus* were present, such as on Taroa (Maloelap Atoll), Mile (Mile Atoll) and Wotje (Wotje Atoll) they were common and could be observed scurrying fearlessly on the ground. The rats permitted quite close observation before they ran way. This is also confirmed by members of the Independent Nationwide Radiological Study that took radioactivity measurements on all atolls of the Marshall Islands (Simon pers. comm). The current distribution of *R.rattus/R.norvegicus* is not an artifact of selective or differential observation and reporting.

## POTENTIAL IMPACT OF SHIPBORNE RATS

Given the overall urban and agricultural/horticultural development of the atolls of the Marshall Islands the few bird atolls remain ecological refuges and sea-bird nesting colonies of Pacific-wide significance. Any landing of shipborne rats on board of a stricken vessel is likely to constitute an ecological catastrophe. And shipwrecks, especially of Japanese fishing vessels, are not uncommon (Spennemann, 1991; Thomas, 1989).

However, not all shipwrecks on atolls necessarily introduce rat species. It is possible to compile from the literature quite an extensive list of shipwrecks which occurred in the Marshall Islands over the past 100 years. Yet, none of these vessels introduced any *Rattus rattus* and *Rattus norvegicus*; given the nature of some of the vessels it is highly unlikely that at least some would not have had rats on board (cf. Hezel, 1979). It would appear that the wrecks had all been stranded at locations where the rats could not get ashore or where they died in the surf when the vessels broke up.

The only clear evidence of colonisation by *Rattus rattus* and *Rattus norvegicus* in the Marshalls occurred when ships were moored at piers and where the rats had the chance to run down mooring lines or gangways. The dispersal of *R.rattus/R.norvegicus* is poised to increase as piers to unload the field-trip ships or fishing bases have now been constructed on many atolls. To contain the spread of these two species care needs to be exercised with lines being properly fitted with regulatory rat disks.

In order to avoid the accidental landing of shipborne rats on the bird atolls, however, *extreme* precautions need to be taken, both in view of landing or beaching any support vessels and in view of the unloading and lightening of the stricken (fishing) vessel.

## BIBLIOGRAPHY

Alessio, D. F. 1990. The Likiep documentary. The Likiep taburbur. Waan Aelon Kein Project Report N° 3. Majuro, Marshall Islands: Alele Museum.

Amerson, A.B. 1969. Ornithology of the Marshall and Gilbert Islands. *Atoll Research Bulletin* 127. Washington: Smithsonian Institution.

Amerson, B.J. 1971. The Natural History of French Frigate Shoals, Northwestern Hawaiian Islands. *Atoll Research Bulletin* 150. Washington: Smithsonian Institution.

Amerson, A.B. and P.J.Skelton. 1976. The Natural History of Johnston Atoll, Central Pacific Ocean. *Atoll Research Bulletin* 192. Washington: Smithsonian Institution.

Anonymous, 1895. Denkschriften betreffend (Jahresberichte über) das Schutzgebiet der Marschall-Inseln, 1893-1894). Stenographische Berichte über die Verhandlungen des Reichstages, 1895

Anonymous. 1941. Rats-crabs-birds; how PAA unwittingly upset nature's balance at Wake Island. Pacific Islands Monthly Vol. 12 (3), October 1941, Page 68.

Atkinson, I.A.E. 1973. The spread of the ship rat (*Rattus r. rattus* L.) in New Zealand. *Journal of the Royal Society of New Zealand* 3, 457-472.

Atkinson, I.A.E. 1978. Evidence for the effects of rodents on the vertebrate wildlife on New Zealand islands. In: P.R. Dingwall (ed.), *The ecology and control of Rodents in New Zealand nature reserves; Proceedings of a Seminar convened by the Department of Lands and Survey, held in Wellington on 29-30 November 1978*Wellington: Department of Lands and Survey Information Series 4. Pp.75-86.

Austin, O.L. 1948. Predation by the common rat (*Rattus norvegicus*) in the Cape Cod Colonies of nesting terns. *Bird banding* 19, 60-65.

Bailey, A.M. and J.H.Sorensen. 1962. Subantarctic Campbell Island. *Proceedings of the Denver Museum of Natural History* 10.

Balazas, G.H. 1983. Sea turtles and their traditional usage in Tokelau. *Atoll Research Bulletin* 279. Washington: Smithonian Institution.

Berry, R.J., and W.B.Jackson. 1979. House mice on Enewetak Atoll. *Journal of Mammalogy* 60, 222-225.

Betlack, J.T. and W.C.Eckhardt. 1945. *Majuro Naval Air Base 3234. An informal record of life on Majuro in words and pictures 1944-1945.* No place given.

Bettesworth, D.J. 1972. *Rattus exulans* on Red Mercury Island. *Tane* 18, 117-118.

Bettesworth, D.J. and G.V.Anderson. 1972. Diet of *Rattus norvegicus* on Whale Island, Bay of Plenty, New Zealand. *Tane* 18, 189-195.

Bianchi, F. and R.Smythe. 1965. *Report of Rodent Control Clinic given in Tonga 1965.* Sponsored by the East-West Center, University of Hawaii. Mimeographed.

Bonin, M.J. 1982. *Work report Rodent Control Section, April to October 1982. Samoan-German Plant Protection Project.* Nu'u Crop Development Station. Apia: Department of Agriculture and Forests, Crop Protection Station.

Bonin, M.J. 1986. Rat damage to cocoa in Western Samoa. In: Anonymus (ed.), *[Proceedings of the] UNDP/FAO/GTZ/IRETA Regional Crop Protection Workshop 8-12 September 1986, Apia, Western Samoa.* Suva: UNDP/FAO/SPC Plant Protection and Root Crops Development Project. pp. 213-219.

Bourne, W.R.P. 1981. Rats as avaian predators. *Atoll Research Bulletin* 255. Washington: Smithonian Institution. Pp. 69-71.

Braestrup, F.W. 1956. The significance of the strong 'oceanic' affinities of the vertebrate fauna on Rennell Island. In: R. Wolff (ed.), *The natural history of Rennell Island, British Solomon Islands.* Vol. 1: (Vertebrates) Copenhagen, Danish Science Press. Pp. 135-148.

Browning, M.A. 1972. Walab im meto: canoes and navigation in the Marshalls. *Oceans*, 5(1), 25-38.

Bryan, E.H. 1959. Notes on the geography and natural history of Wake Island. *Atoll Research Bulletin* 66. Washington: Pacific Science Board.

Bryan, E.H. 1972. *Life in the Marshall Islands.* Honolulu, Hawaii: Pacific Scientific Information Center.

Canter Visscher, T.W. 1957. *A survey on rat damage to coconuts and its effects on yields.* Ms. held on file. Ministry of Agriculture, Forestry and Fisheries, Nuku'alofa (not seen).

Cassin, J., 1858. Mammalogy and Ornithology. In: *U.S.Exploring Expedition*, Vol 8, Philadelphia: J.L.Lippincott.

Chamisso, A. von. 1910. *Reise um die Welt mit der Romanzoffschen Entdeckungs-expedition in den Jahren 1815-1818 auf der Brig Rurik, Capitaen Otto v. Kotzebue* Zweiter Theil: Bemerkungen und Ansichten. Chamisso's Werke Vierter Theil. Berlin: G.Hempel. (For the benefit of the anglophone readers I have quoted as much as posible the English translation [Univ. Hawaii Press 1986] rather than the German original [1st edition] of 1836. However, the translation of Notes and Opinions is not complete).

Chamisso, A. von. 1986. *A yoyage around the world with the Romanzov exploring expedition in the years 1815-1818 in the Brig Rurick, Captain Otto von Kotzebue.* (translated by H.Kratz). Honolulu: University of Hawaii Press.

Crook, I.G. 1973. The tuatara, *Sphenodon puntatus* gray, on islands with and without populations of the Polynesian rat, *Rattus exulans* Peale. *Proceedings of the New Zealand Ecological Society* 20, 115-120.

Crowell, K.L. 1986. A comparison of relict versus equilibrium models for insular mammals in the gulf of Maine. *Biological Journal of the Linnean Society* 28, 1-2), 37-64.

Cunningham, W.S. 1961. *Wake Island Command.* Boston: Little, Brown and Co.

Daniel, M.J. 1973. Seasonal diet of the ship rat (*Rattus r. rattus*) in a lowland forest in New Zealand. *Proceedings of the New Zealand Ecological Society* 20, 21-30.

Davidson, J.M. 1971. Archaeology on Nukuoro Atoll, a Polynesian outlier in the Eastern Caroline Islands. Bulletin of the Auckland Institute and Museum 9. Auckland: Auckland Institute and Museum.

Devereux, J.P.S. 1947. *The story of Wake Island.* Philadelphia, New York: Lippincott Co.

Diamond, J. 1987. How do flightless animals colonise oceanic islands? *Nature* 327, 374.

Dye, T.S. 1987. *Social and cultural change in the Ancestral Polynesian homeand.* PhD thesis, Yale University.

Egoscue, H.J. 1970. A laboratory colony of the Polynesian rat, *Rattus exulans. Journal of Mammology* 51, 261-266.

Erdland, A. 1914. *Die Marschall-Insulaner.* Anthropos Ethnologische Bibliothek. Münster i.W. Bd. 2, Heft 1.

Fall, M.W., A.B.Medina and W.B. Jackson. 1971. Feeding patterns of *Rattus rattus* and *Rattus exulans* on Eniwetok Atoll, Marshall Islands. *Journal of Mammalogy* 52, 69-76.

Finsch, O., 1887. Canoes und Canoebau in den Marschall-Inseln. *Zeitschrift für Ethnologie Verhandlungen der Berliner anthropologischen Gesellschaft* 19, 22-2.

Finsch, O., 1893. Ethnographische Erfahrungen und Belegstücke aus der Südsee. *Annalen des K. & K. Naturhistorischen Hofmuseums* 7. Vienna: K. & K. Naturhistorisches Hofmuseum.

Fosberg, F.R. 1955. Northern Marshall Islands Expedition 1951-1952. Narrative. *Atoll Research Bulletin* 37. Washington: Pacific Science Board.

Fosberg, F.R. 1956. *Military Geography of the Northern Marshalls.* Engineer Intelligence Dossier, Strategic Study Marshall, Subfile 19, Analysis of the Natural Environment. Prepared under the direction of the Chief of Engineers, U.S.Army by the Intelligence

Division Office of the Engineer Headquarters United States Army Forces Far East with personnel of the United States Geological Survey.

Fosberg, F.R. 1957. Lonely Pokak. *Living Wilderness* 62, 1-4.

Fosberg, F.R. 1959. Notes on rats and pest control on Wake Island, 1952. In: E.H.Bryan, Notes on the geography and natural history of Wake Island. *Atoll Research Bulletin* 66. Washington: Pacific Science Board. pp. 7-8

Fosberg, F.R. 1961. VIII.Flora and vegetation. In: D.I.Blumenstock (ed.) A report on Typhoon effects upon Jaluit Atoll. *Atoll Resarch Bulletin* 75. Washington, D.C.: Pacific Science Board. Pp. 51-55.,

Fosberg, F.R. 1990. A review of the Natural History of the Marshall Islands. *Atoll Research Bulletin*. 330. Washington: Smithonian Institution.

Fosberg, F.R. and M.-H. Sachet. 1962. Vascular Plants recorded from Jaluit Atoll. *Atoll Research Bulletin* 92. Washington: Pacific Science Board.

Foulton, J.F. 1939. A trip to Bohol in search of tarsius. *Yale Journal of Biology and Medicine* 11, 561-573.

Friend, D. 1971. Rat damage to Cocoa in the Solomons. *South Pacific Bulletin* 1971 (1). 19-21.

Gifford, E.W. 1929. Tongan Society. *Bernice P.Bishop Museum Bulletin* 61. Honolulu: Bernice P.Bishop Museum.

Gressitt, J.L. 1961, Terrestrial fauna. In: D.I.Blumenstock (ed.) A report on Typhoon effects upon Jaluit Atoll. *Atoll Resarch Bulletin* 75. Washington, D.C.: Pacific Science Board. Pp. 69-73.

Grooch, W.S. 1936. *Skyway to Asia*. New York: Longman and Green.

Halafihi, M. 1985. Report on rat damage survey at the Vava'u Group. Ms. on file. Tongan-German Plant Protection Project, Research Division, Ministry of Agriculture, Forestry and Fisheries, Vaini Research Farm.

Hambruch, P. 1912. Die Schiffahrt auf den Karolinen- und Marschall-Inseln. *Meereskunde* VI. Berlin.

Hanski, I. 1986. Population dynamics of shrews on small islands accord with equilibrium model. *Biological Journal of the Linnean Society* 28, 1-2), 23-36.

Harrison, J.L. 1954.The natural food of some rats and other mammals. *Bulletin of the Raffles Museum, Singapore* 25, 157-165.

Harrison, J.L. 1961. The natural food of some Malayan mammals. *Bulletin of the National Museum of Singapore* 30,5-18.

Hatheway, W.H. 1953. The Land Vegetation of Arno Atoll, Marshall Islands. *Atoll Research Bulletin* 16. Washington: Pacific Science Board, National Research Council.

Heaney, C.R. 1986. Biogeography of mammals in South-East Asia: estimates of values of colonisation, extinction and speciation. *Biological Journal of the Linnean Society* 28, 1-2), 127-165.

Hernsheim, F., 1887. Die Marshall-Inseln. *Mittheilungen der geographischen Gesellschaft in Hamburg* 1885-1886, 1887), 297-308.

Hezel, F.J. 1979. *Foreign ships in Micronesia. A compendium of ship contacts with the Caroline and Marshall Islands 1521-1885.* Saipan, Mariana Is.: F.J.Hezel and Trust Territory Historic Preservation Office.

Hezel, F.X. 1983. The First Taint of Civilisation. A History of the Caroline and Marshall Islands in Pre-Colonial Days, 1521-1885. *Pacific Islands Monographs Series,* No.1. Honolulu: University of Hawaii Press.

Hoeck, H.N. 1984. Introduced mammals. In: R. Perry (ed.), *Key environments: Galapagos.* Oxford: Pergamon Press. pp. 233-246.

Jackson, W.B. 1969. Survival of rats on Eniwetok Atoll. *Pacific Science* 23, 265-275.

Jackson, W.B., and R.L. Strecker. 1962. Ecological Distribution and relative numbers. In: N. Storer, Pacific Island Rat Ecology. Report on a study made on Ponape and adjacent islands 1955 - 1958. *Bernice P.Bishop Museum Bulletin* 225. Honolulu: Bernice P.Bishop Museum. Pp. 45-63.

Japanese Government. 1929. *Annual report to the League of Nationson the administration of the South Sea Islands under Japanese Mandate for the year 1929.* [Tokyo]: Japanese Government.

Kephart, R. 1950. *Wake, war and waiting.* New York:Exposition Press.

Kirch. P.V. 1988. Niuatoputapu. The prehistory of a Polynesian Chiefdom. *Thomas Burke Memorial Wqashington State Museum Monograph* N° 5 Seattle: Burke Museum.

Kirch, P.V. & D.E. Yen. 1982. Tikopia. The prehistory and ecology of an Polynesian outlier. *Bernice P. Bishop Museum Bulletin* 238. Honolulu: Bernice P. Bishop Museum.

Kotzebue, O.von, 1830. A *new voyage around the world in the years 1823-1826.* London: H.Colbourn & R.Bentley.

Krämer, A. 1905. Der *Haus- und Bootsbau auf den Marschallinseln (Ralik-Ratak-Inseln).* Archiv für Anthropologie N.F. III Braunschweig: Friedrich Vieweg and Sohn.

Krämer, A. and H.Nevermann. 1938. Ralik-Ratak (Marschall Inseln). *In:* G.Thilenius (ed.), *Ergebnisse der Südsee-Expedition 1908-1910. II. Ethnographie, B: Mikronesien.* Vol. 11: Hamburg: Friedrichsen and de Gruyter.

Lamberson, J.O. 1987. Reptiles of Enewetak Atoll. In: Devaney, D.N., E.S.Reese, B.L.Burch and P.Helfrich, *The Natural History of Enewetak Atoll. Volume I Biogeography and Systematics.* Oak Ridge, Ten.: U.S.Department of Energy, Office of Scientific and Technical Information. Pp. 325-329.

Leach, B.F. & G.Ward. 1981. Archaeology on Kapingamarangi Atoll. *University of Otagoa Studies in Prehistoric Anthropology* 15. Dunedin: Department of Anthropology, Universty of Otago.

Langdon, R. 1978. American whalers and traders in the Pacific: A guide to Microfilms. Canberra: Bacific Manuscripts Bureau, Research School of Pacific Studies, The Australian National University.

Langdon, R. 1979. *Thar she went: an interim index to the Pacific Ports and islands visited by American whalers and traders in the 19th century being a supplement to "American whalers and traders in the Pacific: A guide to Microfilms".* Canberra: Bacific Manuscripts Bureau, Research School of Pacific Studies, The Australian National University.

Linckens, H. 1912. *Auf den Marshall Inseln (Deutsche Südsee). Land und Leute. Katholische Missionsthätigkeit.* Hiltrup: Herz-Jesu Missionare.

Lomolino, M.V. 1986. Mammalian community structure on islands: the importance of immigration, extinction and interactive effects. *Biological Journal of the Linnean Society* 28, 1-2), 1-21.

Luomala, K. 1975. Cultural associations of land mammals in the Gilbert Islands. Bernice P. Bishop Museum Occasional Paper 24 (13). Honolulu: Bernice P. Bishop Museum.

Marshall, J.T. 1950. Vertebrate ecology of Arno Atoll. *Atoll Research Bulletin* 3. Washington: Pacific Science Board.

Marshall, J.T. 1957. Atolls visited during the first phase of the Pacific Islands Rats Ecology project. *Atoll Research Bulletin* 56. Washington: Pacific Science Board.

Martin, J., 1817. An account of the natives of the Tonga Islands, in the South Pacific Ocean with an original grammar and vocabulary of their language. London: John Murray.

Merz, G. 1910. Rundreise mit "Delphin". Kaiserliches Bezirksamt Journal No. 1324/10. Report to the Imperial Governor at Rabaul., dated Jaluit, September 6th, 1910. Ms. on file. Reichskolonialamt Volume 3077., Document 23 Australian Archives, G-2, Y40

Miller, W.B. 1936. Flying the Pacific. *National Geographic Magazine* 70(6), December 1936, 664-708

Morrison, J.P.E. 1954. Animal Ecology of Raroia Atoll, Tuamotus. *Atoll Research Bulletin* 34. Washington: Smithonian Institution.

Moseby, J.M., K.Wodzicki and H.R.Thompson. 1973. Food of the kimoa *Rattus exulans* in the Tokelau Islands and other Habitats in the Pacific. *New Zeland Journal of Science* 16, 799-810.

Norman, F.I. 1975. The murine rodents *Rattus rattus, exulans* and *norvegicus* as avian predators. *Atoll Research Bulletin* 182, 1-13.

Parr, Ch.M. 1941. Over and above our Pacific. New York:Whole World and Co.

Peale, T.R., 1848. Mammals and Ornithology. In: *U.S.Exploring Expedition*, Vol 8, Philadelphia: Lea and Blanchard.

Pickering, C., 1879. Geographical distribution of animals and plants. *U.S.Exploring Expedition* 19 (2), 1-524. Philadelphia:C.Sherman.

Picking, S. 1922. Wake Island. Report by U.S.S.*Beaver* on a visit to Wake Atoll. Ms. held at Bernice P.Bishop Museum. Manuscripts of the Tanager Expedition, File 2.12. 3 pp.

Pierce, L.H. 1971a,.*Preliminary report on rat damage to coconuts on Tongatapu 1970-1971.* Ms. held on file, Ministry of Agriculture, Forestry and Fisheries, Nuku'alofa, Kingdom of Tonga.

Pierce, L.H. 1971b. Rodent Control in Tonga. *South Pacific Bulletin* 1971 (4), 39-41.

Poole, A.J. & V.S.Schantz. 1942. Catalog of type specimens of mammals in the U.S. National Museum. *U.S.National Museum Bulletin* 178. Washington, D.C.: U.S.National Museum.

Poulsen, J.I. 1987. Early Tongan Prehistory. *Terra Australis* 12. Canberra: Department of Prehistory, Research School of Pacific Studies, The Australian National University.

Pregill, G.K. and T.Dye. 1988. Prehistoric extinction of giant iguanas in Tonga. *Copeia* 1989(2), 505-508.

Price, W.H. 1936. *Rip-tide in the South Seas.* London: Heinemann.

Ramsay, G.W. 1978. A review of the effect of rodents on New Zealand inverebrate fauna. In: P.R. Dingwall (ed.), *The ecology and control of Rodents in New Zealand nature reserves; Proceedings of a Seminar convened by the Department of Lands and Survey, held in Wellington on 29-30 November 1978*Wellington: Department of Lands and Survey Information Series 4. Pp. 87-90.

Richard, D.E. 1957. *The United States Naval Administration of the Trust Territory of the Pacific Islands. Vol. 1: The Wartime Military Government Period 1942-1945.* Washington, DC: U.S. General Printing Office.

Schubel, S. and D.W.Steadman. 1942. More bird bones from Polynesian Archaeological sites on Henderson Island, Pitcairn Group, South Pacific. *Atoll Research Bulletin* 325. Washington, DC: Smitonian Institution

Sinoto, Y.H. 1983. Archaeology of Henderson I. *Atoll Research Bulletin* 272. Washington: Smithonian Institution.

Spennemann, D.H.R. 1987. *The Extension of the Facilities of Nafanua Harbour at Ohonua, 'Eua Island, Kingdom of Tonga. Report on the Impact on Archaeological Sites in the Area. Final Report.* Melbourne: Riedel & Byrne.

Spennemann, D.H.R. 1988. Rat remains from an archaeological site at Tongoleleka, Lifuka island, Ha'apai group, Kingdom of Tonga. Osteological Report DRS 50. 1988). Ms. on file. Department of Prehistory. Research School of Pacific Studies, Australian National University, Canberra.

Spennemann, D.H.R. 1989. *'ata 'a Tonga mo 'ata 'o Tonga: Early and Later Prehistory of the Tongan Islands.* Unpublished PhD Thesis, Department of Prehistory, Research School of Pacific Studies, The Australian National University, Canberra, Australia.

Spennemann, D.H.R. 1991. *The grounding of the Kinsho Maru N°8 Potential impact of shipborne rats on the avifauna of Bokak Atoll.* Report to the Republic of the Marshall Islands Environmental Protection Office. Division of Archaeology, History and Traditional Material Culture, Alele Museum, Majuro Atoll,Republic of the Marshall Islands

Spennemann, D.H.R. 1992. *Cultural Resource Managment Plan for Majuro Atoll, Republic of the Marshall Islands.* 2 Vols. Washington: U.S.Department of Interior, Office of Territorial and International Affairs.

Spennemann, D.H.R. 1996. Gifts from the waves. A case of marine transport of obsidian to Nadikdik Atoll and the occurrence of other drift materials in the Marshall Islands. *Johnstone Centre of Parks, Recreation and Heritage* Report N° 23. Albury, NSW.: Charles Sturt University, The Johnstone Centre of Parks, Recreation and Heritage

Spennemann, D.H.R. in press. On the origin of drift materials in the Marshall Islands. *Atoll Research Bulletin* .

Spennemann, D.H.R. and G.Rapp. 1987. Swimming capabilities of the black rat *Rattus rattus* in tropical lagoonal waters in Tonga. *Alafua Agricultural Bulletin* (Western Samoa), 12 (2). 1987, 17-19.

Spennemann, D.H.R. and G.Rapp. 1989. Can rats colonise oceanic islands unaided? An assessment and review of the swimming capabilities of the genus *Rattus*

(Rodentia:Muridae) with particular reference to tropical waters. *Zoologische Abhandlungen des Museums für Tierkunde Dresden* 45(1). 1989, 81-91.

Steinbach, E. 1893. Bericht über die Gesundheitsverhältnisse der Schutzgebiete der Marshall-Inseln. *Mittheilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten* 6, 306-313.

Stevenson, F. 1914. ("Mrs.R.L.Stevenson"), The Cruise of the Janet Nichol among the South Sea Islands. New York: Charles Scribner's Sons.

Storer, N. 1962. Pacific Island Rat Ecology. Report on a study made on Ponape and adjacent islands 1955 - 1958. *Bernice P.Bishop Museum Bulletin* 225. Honolulu: Bernice P.Bishop Museum

Swink, F.N., J.P. Suamangil, G.K.LaVoie, A.de la Paz, R.R.West, D.C. Tolentino, J.L.Libay, G.C.Atwell, D.C.Sanches and N.B.Kverno. 1970. *Rodent Research Center 1970 Annual Progress Report.* Manila: University of the Philippines, Bureau of Plant Industry.

Tate, G.H.H. 1935. 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. *Bulletin of the American Natural History Museum* 68 (3), 145-178.

Thomas, P.E. 1989. *Report of the Northern Marshall Islands Natural Diversity and Protected Areas Survey, 7-24 September* 1988. Noumea: SPREP.

Tobin, J.E. 1952. Land tenure in the Marshall Islands. *Atoll Research Bulletin* 11. Washington: Pacific Science Board, National Research Council.

Tomich, P.Q. 1970. Movement patterns of field rodents in Hawaii. *Pacific Science* 24. 195-234.

Tomich, P.Q. 1986. Mammals in Hawaii. A synopsis and notational Bibliography. 2nd edition. *Bernice P.Bishop Museum Special Publication* 76. Honolulu: Bernice P.Bishop Museum.

Twibell, J. 1973. The Ecology of rodents in the Tonga Islands. *Pacific Science* 27, 92-98.

Vason, G., 1810. *Authentic narrative of four years residence at Tongataboo, one of the Friendly Islands in the South Sea, by _____ who went thither in the Duff, under Captain Wilson, in 1796.* London: Longman, Hurst, Riks and Orme.

Ward, G.W., J.S. Webb and M.Levison. 1973. The settlement of the Polynesian outliers: a computer suimulation. *Journal of the Polynesian Society* 82, 330-342.

Watts, C.H.S. and H.J.Aslin. 1981. *The rodents of Australia.* Sydney: Angus and Robertson.

Werstein, I. 1964. *Wake. The story of a battle.* New York: Thomaas Y. Crowell. Co.

Whitaker, A.H. 1973. Lizard populations on islands with and without Polynesian rats, *Rattus exulans* (peale). *Proceedings of the New Zealand Ecological Society* 20, 121-130.

Whitaker, A.H. 1978. The effects of rodents on reptiles and amphibians. In: P.R. Dingwall (ed.), *The ecology and control of Rodents in New Zealand nature reserves; Proceedings of a Seminar convened by the Department of Lands and Survey, held in Wellington on 29-30 November 1978*Wellington: Department of Lands and Survey Information Series 4. Pp. 75-86.

Williams, J.M. 1982. Rat damage, ecology and control in the South Pacific. pp. 75-99. In: Anonymus (ed.), *Subregional training course on methods of controlling diseases, insects and other pests of plants in the South Pacific. October 4-20. 1982.* Government Experimental Farm, Vaini, Ministry of Agriculture, Fisheries and Forests, Nuku'alofa, Kingdom of Tonga.

Williams, J.M. 1974. Rat damage to coconuts in Fiji. Part I: Assessment of damage. *PANS* 20:379-391.

Williams, J.M. 1975. Rat damage to coconuts in Fiji. Part II: efficiency and economics of damage reduction methods. *PANS*. 21. 19-26

Williams, J.M. and J.Misikini. 1972. Rat damage and crop loss. In: J.B.D. Robinson (ed.), *Annual Report 1971*. Suva: Department of Agriculture. Pp. 104-116.

Wodzicki, K. 1969. Preliminary report on damage to coconuts and on the ecology of the Polynesian rat (*Rattus exulans*) in the Tokelau islands. *Proceedings of the New Zealand Ecological Society* 16, 7-12.

Yanaihara, T., 1940. *Pacific Islands under Japanese Mandate*. Oxford: Oxford University Press.

**Personal communication**

Clark, J. 1996. Division of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University, Canberra, Australia.

Simon, S. 1993. Independent Nationwide Radiological Survey, Majuro Atoll, Marshall Islands.