Final report on an investigation of the original non-volant mammal fauna of Nanga Station, Shark Bay.

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SUMMARY

During field work in 2006 the coasts of Nanga Station were searched for sites that contained remains of mammals dating to pre-European times. Ten new sites, five in small caves and five in sand dune 'blowouts', were discovered, but none contained the quantity or diversity of remains found in a previously-discovered site on the northern boundary of the Station. The original mammal fauna derived from this evidence consists of one monotreme, seven dasyurids, two bandicoots, one rat-kangaroo, five kangaroos and wallabies, eight rodents and the Dingo, and is basically the same as that of the Peron Peninsula. No evidence has been found for bat species, which would have been, and probably all still are, present. Depending upon where the southern and western boundaries of Nanga Station lie, the southern extremities of the station could have originally carried mammal members of the southwestern sandplain fauna, such as the Honey Possum.

INTRODUCTION

Because of the high level of extinction of the native fauna of Australia since European colonization, especially among mammals and particularly in the more arid parts of the continent, the present day fauna is often quite depauperate in comparison to the original (i.e. immediately pre-European) fauna. Knowledge of the original fauna is therefore vital for informed management and re-introduction of species to conservation areas such as Nanga Station.

'Subfossil' skeletal remains represent one of the most important means of discovering the original mammal fauna of an area. Such material is most often found in caves or dune 'blowouts' (in which the wind has removed the light particles, leaving a surface lag deposit of rocks, wood, snail shells and bones). Remains accumulate in such sites because they provide shelters for predators (both bird and mammal) and protect the bones of their prey from weathering. Both types of site have been found to be productive on the peninsulas and islands of Shark Bay (Baynes 1990, 2000a, 2000b, 2006).

In May 2000 the author spent three days searching for sites on Peron Peninsula, with Brett Fitzgerald (then the Project Eden Officer), with considerable success. Five blowout and 12 cave sites containing bones were discovered in coastal areas (Baynes 2000b). On the basis of this experience, it was anticipated that sites would be equally plentiful along the coasts of Nanga Station, and that at least one or two of these would contain large accumulations of bones. It was hoped that this would not only provide evidence of the original fauna of Nanga Station, but also reveal a relaxation of the peninsula effect on species richness.

2006 FIELDWORK

With advice from, and assistance by DEC Denham office staff, particularly Ross Mack, I explored all accessible sections of the coastline of Nanga Station for sites that might contain mammal remains, concentrating on small caves in coastal limestone formations, and blowouts in mobile, 'white', sand dunes. Advice from Ross Mack, distant views along the coasts and a serendipitous aerial view from a Skywest aircraft *en route* to Perth, indicate that areas that were not accessed lack both limestone formations and mobile sand dunes. In addition to searching Nanga Station for new sites, I returned to the Goulet Bluff 8 site found in May 2000 immediately 'north' of the feral fence that forms the northern boundary of Nanga, and dug out and sieved the top 10 cm of the sediment it contained. Although 10 new sites were found on Nanga, none contained really large amounts of bone. So I returned towards the end of the field season to a cave site (designated N3) half way along the east coast of the Petit Point peninsula, and dug out and sieved its contents also.

SITES

The 10 new sites discovered on Nanga Station during the course of field work in 2006 are listed below, plus the Goulet Bluff 8 site discovered in May 2000, with GPS co-ordinates and altitude above sea level (a.s.l.).

GB8. Small cave in a limestone 'head' in the cliff at the inland side of a narrow coastal flat that lies immediately 'north' of the feral fence that forms the boundary of Nanga Station, discovered by A. Baynes and B.A. Fitzgerald, May 2000. GPS [WGS 84]: 26°14'16"S., 113°46'06"E., 3 m a.s.l. Sediment dug out to a depth of 10 cm and sieved by A. Baynes 13-14 Jul 2006.

N1. Blowout in cream-coloured sand dune near Petit Point, discovered by A. Baynes and J.R. Mack, 17 Jul 2006. GPS [WGS 84]: 25°59'01"S., 113°54'46"E., 5 m a.s.l. Bones picked from the surface of the sand.

N2. Blowout in cream-coloured sand dune near Petit Point, discovered by A. Baynes and J.R. Mack, 17 Jul 2006. GPS [WGS 84]: 25°59'01"S., 113°54'42"E., 4 m a.s.l. Bones picked from the surface of the sand.

N3. Small cave in a line of ?limestone rock in a cliff slope at the western (inland) side of a coastal flat on the east coast of Petit Point Peninsula, discovered by A. Baynes and J.R. Mack, 17 Jul 2006. GPS [WGS 84]: 26°02'26"S., 113°53'36"E., 18 m a.s.l. Sediment dug out to a depth of 5 cm and sieved by A. Baynes 21 Nov 2006.

N4. Blowout in cream-coloured coastal sand dune, west coast of Nanga Station, near the feral fence, discovered by A. Baynes, 19 Jul 2006. GPS [WGS 84]: 26°14'36"S., 113°46'58"E., 2 m a.s.l. Bones picked from the surface of the sand.

N5. Blowout in cream-coloured coastal sand dune, west coast of Nanga Station, discovered by B.A. Fitzgerald, A. Baynes and W.A. Dekker, 5 Aug 2006. GPS [WGS 84]: 26°18'28"S., 113°51'48"E., 0 m a.s.l. Bones picked from the surface of the sand.

N6. Blowout in cream-coloured coastal sand dune, west coast of Nanga Station, discovered by A. Baynes, B.A. Fitzgerald and W.A. Dekker, 5 Aug 2006. GPS [WGS 84]: 26°18'22"S., 113°51'41"E., 0 m a.s.l. Bones picked from the surface of the sand.

N7. Small cave in coastal limestone head, west coast of Nanga Station, discovered by A. Baynes 14 Sep 2006. GPS [WGS 84]: 26°21'15"S., 113°52'53"E., 9 m a.s.l. Bones picked from the sand within the cave and the talus slope below.

N8. Tiny cave in coastal limestone, west coast of Nanga Station, discovered by A. Baynes 18 Sep 2006. GPS [WGS 84]: 26°19'30"S., 113°52'26"E., 5 m a.s.l. Bones picked from the sandy talus slope below the entrance.

N9. Small fissure in coastal limestone, west coast of Nanga Station, discovered by A. Baynes 18 Sep 2006. GPS [WGS 84]: 26°19'36"S., 113°52'30"E., 5 m a.s.l. Bones picked from the sand within the cave and the talus slope below.

N10. Small fissure in coastal limestone, west coast of Nanga Station, discovered by A. Baynes 18 Sep 2006. GPS [WGS 84]: 26°19'39"S., 113°52'33"E., 3 m a.s.l. Bones picked from the sand within the cave and the talus slope below.

RESULTS

Mammal species whose remains have been identified from sites GB8 and N1 to N10, and/or which were observed as living animals during the fieldwork, are shown in Table 1. For compactness vernacular names of species are omitted from Table 1, but given in Table 2, below. The results in Table 1 illustrate the point that no large new sites, to rival GB8 in terms of quantity of bone material or diversity of species represented, were there to be discovered on Nanga Station during the 2006 field work.

The probable record of *Sminthopsis hirtipes* in site N3 is based upon a single blade-like (as opposed to conical) third upper premolar. Such teeth are characteristic of *S. hirtipes*, but premolars are not really an adequate basis for firm records of dasyurids. The record is consistent with the results obtained by McKenzie et al. (2000), who found *S. hirtipes* on both their Peron and (southern) Nanga study sites. The probable record of *Lagorchestes hirsutus* in N4 is also based upon a single tooth, in that case the cap of a lower molar, probably M_3. It is clearly not *Lagostrophus*, which has molars that are very characteristically different from those of other macropodids, and the N4 molar is larger than those of *Onychogalea lunata* and has a different midlink structure. These characteristics are consistent with *L. hirsutus* but not completely exclusive to that species. The third record that is based upon only a single tooth is that of *Notomys amplus* in GB8. In that case, however, it is a complete unworn first lower molar which is structurally characteristic of the species, and considerably different from those of any other species recorded from the deposit (in particular in having much more sloping lophs).

Although a very much larger sample from GB8 was processed in 2006 than 2000, only four additional species were recorded, compared to Baynes (2000b). This is probably due in part to the asymptotic nature of the relationship between sample size and number of species revealed, but may also indicate that virtually all the species that could be sampled by the accumulating agents operating from the site are recorded.

The most important accumulating agent for the remains in the sites was probably the Barn Owl, *Tyto alba*. Much of the bone material is relatively undamaged, particularly in GB8, which also contained pieces of eggshell. These are consistent with Barn Owl in inferred size of the original egg, and white colour, though the pore structure has not been examined to confirm the identification. Remains of mammalian carnivores, particularly Chuditch (*Dasyurus geoffroii*), are recorded from some sites, and Fox and Cat are also recorded from GB8. Two sites, N3 and N10, appear to have been accumulated mainly or entirely by mammalian carnivores, probably Chuditch: the sites are in caves that are too low or open to have been suitable as owl roosts and the bones in them are either broken into small pieces and/or bear tooth marks. The presence of a small number of broken remains of larger species (*Lagostrophus fasciatus* and *Onychogalea lunata*) in N3 suggests that a larger

carnivore, probably Dingo, also contributed some bones to that deposit. Some of the bone specimens found in the open sites N4-N6 might also be the remains of carnivore scat. The highly fragmented bones and isolated teeth and/or tooth fragments, particularly in N3, make the task of identification much harder and much more time consuming.

Remains of Rabbits (*Oryctolagus cuniculus*) are recorded from four sites, and were found in five sites on Peron Peninsula by Baynes (2000b). Rabbit bones are very common in coastal sections, where their remains are probably dropped by Foxes and eagles, but these were only collected when they were with remains of native species in designated sites. Importantly, not a single House Mouse (*Mus musculus*) specimen is recorded from any of the sites; though, as in practically all of mainland Australia, *Mus* is a member of the present day fauna of the area (McKenzie *et al.* 2000). This indicates that the native mammal remains were accumulated before European colonization affected the area, and truly represent the original fauna.

The specimens resulting from this investigation will be registered in the vertebrate palaeontological collection of the Western Australian within the catalogue number range 07.1.1 to 07.1.300.

ORIGINAL MAMMAL FAUNA OF NANGA STATION

Inferred original mammal fauna

The inferred original non-volant mammal fauna of Nanga Station is listed in Table 2. There is generally a gratifying consistency that species' remains are recorded from both Peron Peninsula and Nanga Station sites, and often as live-caught animals as well. Exceptions are Fat-tailed Dunnart (*Sminthopsis crassicaudata*), Western Grey Kangaroo (*Macropus fuliginosus*), Short-tailed Hopping-mouse (*Notomys amplus*) and Desert Mouse (*Pseudomys desertor*). Fat-tailed Dunnart was only trapped by McKenzie *et al.* (2000) in samphire communities on evaporite surfaces around birridas. Its remains (which are easily distinguished from other species) are probably not recorded in the sites because such habitats lie beyond the hunting ranges of the accumulating agents living in the coastal sites. On the other hand, the Fat-tailed Dunnart is a species that has benefited from moderate disturbance to habitats by Europeans, and so it is possible that it was genuinely absent from the area prior to European colonization, and has invaded the area subsequently. This appears to be the situation in Kalbarri National Park: the species is not recorded from remains in coastal caves (Baynes 2000a), but is present as a living species in the Park (McKenzie *et al.* 2000). Western Grey Kangaroo was observed on the eastern coast of Freycinet Estuary south of Garden Point (i.e. the southern west coast of Nanga). This lies within Sector 1 of McKenzie *et al.* (2000), where Western Grey Kangaroo was consistently observed. This species' range limit appears to be reached within Nanga Station. As noted above, the Short-tailed Hopping-mouse record is based upon a single specimen from one site, suggesting that the species may have been an extra-limital vagrant in the area. The Desert Mouse is one of several species with limited ranges in the Peron/Nanga area, discussed in the next section.

In a further section below I consider the other mammal species that were potential members of the Nanga original fauna, but which I decided to omit from the inferred list. Before doing so, however, it is necessary to look at the distributional patterns of mammal species across the Shark Bay region, which provide a guide to the other possible 'candidate' species.

Distributional patterns of mammal species in the Shark Bay region

There is a gradient in the rainfall in the Shark Bay region from reliable winter rain on the west coast of Edel Land to less reliable summer rainfall on the inland side of the Bay. It has long been known that this pattern is reflected in the vegetation communities, e.g. Gardner (1944), with a change from the South West Botanic Province to the Eremean Province across Shark Bay. The details of this pattern were refined by Beard (1973, 1980).

Early results on mammal remains from a limited number of cave deposits, suggested a similar pattern in mammals, with southwestern species that reached their range limits at Shark Bay restricted to the western side of Edel Land (Baynes 1990). Results from the search for Bilby remains (Baynes 2000b) on Peron Peninsula, however, showed that two of the southwestern species, Dibbler and Quenda, also originally occurred on the western side of that Peninsula. Those results have been confirmed for Nanga Station (see Table 1), but no other southwestern mammal species has been detected. The Desert Mouse (*Pseudomys desertor*) appears to share this distribution on Nanga. This is unexpected as the species is an arid zone species widely distributed in deserts with sand dunes. Its presence, however, may explain why remains of the morphologically similar Heath Rat (*Pseudomys shortridgei*), which elsewhere precisely matched the range limits of the Dibbler (e.g. both originally occurred on Dirk Hartog Island, Baynes 1990, 2006), have not also been found on Peron Peninsula.

One southwestern species that might have been expected to be limited in its distribution on Nanga is the Banded Hare-wallaby (*Lagostrophus fasciatus*). But it appears to have been widespread on both Peron and Nanga, being recorded not only from western coastal sites but also from Cape Rose and Monkey Mia (Baynes 2000b) as well as Nanga N3 (see Table 1) on the east coast.

Potential members of the Nanga mammal fauna rejected for inclusion in the list

Six mammal species recorded from the Shark Bay region were considered for inclusion in the original fauna, but were rejected for the reasons given below. They are presented in order of likelihood of occurrence on Nanga, rather than in phylogenetic order.

Remains of Boodie (*Bettongia lesueur*) were found in three sites on Peron Peninsula (Baynes 2000b). All three sites were large dune blowouts, and the species was not found in any of the cave sites. Elsewhere Boodie remains occur in cave sites, such as on Dirk Hartog Island (Baynes 2006). This suggests that the Peron specimens represent a past, fossil, distribution and that the species was no longer present on Peron, or Nanga, immediately before European colonization.

Ash-grey Mouse (*Pseudomys albocinereus*) is recorded as present on Peron Peninsula by McKenzie *et al.* (2000), on anecdotal evidence based on a hair sample (Keith Morris pers. comm. 2006). I carefully checked all specimens of *P. hermannsburgensis* (the species with which *P. albocinereus* remains could be confused), but found no evidence for its presence. It is possible that it was and still is present on the west coast of Peron Peninsula, but it appears not to have been among the southwestern species occurring along the west coast of Nanga.

Keith Morris (pers. comm. 2006) believed that he had found scats of Common Brushtail Possum (*Trichosurus vulpecula*) in a site at Herald Bluff on the northeast coast of Peron Peninsula during field work in 2006. I have not identified either scat or bone remains of this species from any of the sites on Peron Peninsula or Nanga, nor is it recorded from any of the sites on Edel Land or at Yaringa on the eastern side of the Bay. The region generally

lacks large hollow trees and caves suitable as shelters for this species. The most likely possibility is the caves in the Zuytdorp Cliffs, but there is no evidence for it having occurred there either. I conclude that Morris' identification was probably incorrect.

Remains of Western Chestnut Mouse (*Pseudomys nanus*) are recorded from Baba Head on Tamala Station to the west of Nanga as well as from the Yaringa sites to the east (Baynes 2000a). This was a species whose remains I was expecting might be discovered in sites on Nanga, but I found no evidence for it. It probably requires more rocky habitats than are present on Nanga.

Remains of Long-tailed Hopping-mouse (*Notomys longicaudatus*) are similarly recorded from Baba Head (one specimen) and all sites at Yaringa (Baynes 2000a). The species occurred on clay-loam and clay substrates (John Gilbert in Gould 1863), meaning that there was no suitable habitat for it on Nanga.

Remains of short-nosed bandicoots (genus *Isoodon*) are found in the Yaringa sites. These I identified as Golden Bandicoot (*I. auratus*) in Baynes (2000a). According to unpublished molecular systematic data, *I. auratus* and *I. obesulus* are one and the same species. Yet they can be distinguished morphologically: *I. auratus* has a smaller upper 4th molar and larger bullae, suggesting a lack of gene flow between the populations. It is possible that opposite ends of a ring-species originally met in the Shark Bay region, or that there was a step-cline. Sadly, all the native populations in the region are now extinct so the situation can probably never be elucidated (although DNA from cave remains might one day cast some light on the matter). From a practical point of view, if the re-introduction of Quendas to Peron fails (probably because the only stock available are from southern populations that are poorly adapted to hot dry conditions), it would probably be legitimate to substitute Golden Bandicoots from the Barrow Island stock, which would probably thrive (though they might not be adapted to cold winter nights!).

Mammal fauna of the southern extremities of Nanga Station

Depending upon where the current southern and western boundaries of Nanga Station lie, the original mammal fauna of its southern extremities may have included more of the southwestern mammal species discussed above. Unfortunately, it is unlikely that any evidence can be found of this fauna, because of a lack of sites to preserve the animals' remains. But in this context the living fauna recorded from the Zuytdorp study area a little further south by McKenzie *et al.* (2000) is probably relevant. In addition to species already recorded from Nanga, they found White-tailed Dunnart (*Sminthopsis granulipes*), Honey Possum (*Tarsipes rostratus*) and Ash-grey Mouse. Heath Rat (*Pseudomys shortridgei*) is likely also to have originally been part of that community, but now locally extinct. Any or all of those species may have occurred within the original boundaries of Nanga Station. Future trapping may reveal how many still occur there.

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Table 1. The terrestrial mammal fauna identified from remains in the Goulet Bluff 8, and Nanga sites N1 to N10 discovered in 2006, plus observations of living animals ("Obs"). X = recorded; (X) = remains other than bone (quill and/or scat); .. = not recorded; ? = less certain record.

	GB8	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	Obs
Tachyglossus aculeatus	..	..	..	(X)	..	..	..	(X)	..	..	(X)	X
Dasycercus sp. indet.	X	..	X	X	..	X	X	..	..	..	..	..
Dasyurus geoffroii	X	..	..	..	..	..	..	X	..	X	X	..
Parantechinus apicalis	X	..	..	..	..	..	..	..	X	..	X	..
Phascogale calura	X	..	..	X	..	..	..	..	..	..	..	..
Sminthopsis dolichura	X	..	..	X	..	..	..	..	..	X	X	..
Sminthopsis hirtipes	..	..	..	?	..	..	..	..	..	..	..	..
Dasyuridae indet.	X	..	..	X	..	..	..	..	..	X	X	..
Isoodon obesulus	X	..	..	..	..	..	..	X	..	X	..	..
Perameles bougainville	X	..	..	X	..	..	..	..	..	..	X	..
Bettongia penicillata	X	..	..	X	..	..	..	..	..	..	..	..
Lagorchestes hirsutus	..	..	..	..	?	..	..	..	..	..	..	..
Lagostrophus fasciatus	X	..	..	X	..	..	..	..	..	..	..	..
Macropus fuliginosus	..	..	..	..	..	..	..	..	..	..	..	X
Macropus robustus	..	..	..	..	..	..	..	..	..	..	..	X
Onychogalea lunata	..	..	..	X	..	..	..	..	..	..	..	..
Oryctolagus cuniculus	X	..	..	X	X	..	..	..	..	X	..	..
Leporillus apicalis	X	X	..	X	..	X	X	X	X	X	X	..
Leporillus conditor	X	..	..	X	X	..	..	..	..	..	..	..
Notomys alexis	X	..	..	X	..	..	..	X	..	X	X	..
Notomys amplus	X	..	..	..	..	..	..	..	..	..	..	..
Pseudomys desertor	X	..	..	..	..	..	..	..	..	..	X	..
Pseudomys fieldi	X	..	..	X	..	..	..	X	..	X	X	..
Pseudomys hermannsburgensis	X	..	..	X	..	..	..	X	..	..	..	..
Rattus tunneyi	X	X	..	X	..	..	X	X	..	X	X	..
Muridae indet.	X	X	X	X	..	X	..	..	X	X	X	..
Vulpes vulpes	X	..	..	..	..	..	..	..	..	..	..	..
Felis catus	X	..	..	..	..	..	..	..	..	..	..	..

Table 2. The inferred original mammal fauna of Nanga Station, Shark Bay. Evidence from remains from sites on Peron Peninsula (P) and/or Nanga Station (including site GB8) (N); and Modern records based on live-caught specimen records (L), mostly recorded as from "Peron Peninsula", and/or observations (O). Data from Table 1, Baynes (2000b) and McKenzie *et al.* (2000). - = no record.

	Remains	Modern
Short-beaked Echidna (*Tachyglossus aculeatus*)	P, N	O
Mulgara or Ampurta (*Dasycercus* sp. indet.)	P, N	-
Chuditch (*Dasyurus geoffroii*)	P, N	L
Dibbler (*Parantechinus apicalis*)	P, N	-
Red-tailed Phascogale (*Phascogale calura*)	P, N	-
Fat-tailed Dunnart (*Sminthopsis crassicaudata*)	-	L
Little long-tailed Dunnart (*Sminthopsis dolichura*)	P, N	L
Hairy-footed Dunnart (*Sminthopsis hirtipes*)	N	L
Quenda (*Isoodon obesulus*)	P, N	-
Western Barred Bandicoot (*Perameles bougainville*)	P, N	L
Woylie (*Bettongia penicillata*)	P, N	L
Mala (*Lagorchestes hirsutus*)	P, N	-
Banded Hare-wallaby (*Lagostrophus fasciatus*)	P, N	-
Western Grey Kangaroo (*Macropus fuliginosus*)	-	O
Euro (*Macropus robustus*)	P	O
Crescent Nailtail Wallaby (*Onychogalea lunata*)	P, N	-
Lesser Stick-nest Rat (*Leporillus apicalis*)	P, N	-
Greater Stick-nest Rat (*Leporillus conditor*)	P, N	-
Spinifex Hopping-mouse (*Notomys alexis*)	P, N	L
Short-tailed Hopping-mouse (*Notomys amplus*)	N	-
Desert Mouse (*Pseudomys desertor*)	N	-
Shark Bay Mouse (*Pseudomys fieldi*)	P, N	L
Sandy Inland Mouse (*Pseudomys hermannsburgensis*)	P, N	L
Pale Field-rat (*Rattus tunneyi*)	P, N	-
Dingo (*Canis lupus dingo*)	P	O