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– ARTICLE –

Human Cultural and Related Remains from Mé Auré Cave (site WMD007), Moindou, New Caledonia

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ABSTRACT

In 1995 a small cave near Mé Auré (site WMD007) on the west coast of New Caledonia, about 120 km northwest of Nouméa, was excavated and found to contain mainly owl and human midden deposits. Some of the contents have already been documented and the present paper completes the study by reporting the human-related materials, including human bone fragments, pottery sherds, bones of four rodent species, and marine mollusc and crab remains. Each of these material classes are reported separately by the authors responsible for their analysis, and the results and interpretations based on each line of evidence are compared and contrasted. The human bone and pottery data suggest a temporally constrained deposit (2750–2350 BP) that has experienced stratigraphic disturbance. This result raises doubt about the un-mixed nature of the deposit emphasized in earlier publications and it urges instead the conclusion that the Mé Auré stratigraphy consists mostly of a redeposited set of horizons. If this conclusion is correct, interpretations already published relying on a fixed chronology, especially about vegetation change and avifauna depletion (Boyer *et al.* 2010) or early aroid introduction (Horrocks *et al.* 2008) will need to be reconsidered. The site constitutes the first in New Caledonia for which a cave deposit has now been fully analysed.

Keywords: New Caledonia, Mé Auré Cave, ceramics, human remains, faunal remains, archaeology

INTRODUCTION

Mé Auré Cave lies near the summit of an unnamed low hill 500 m east of Mé Auré hill, 750 m north of the western coastline of New Caledonia and 13 km west of the town of Moindou (Figures 1 & 2) (Grant-Mackie *et al.* 2003). The low hill is covered in sclerophyll forest remnant and is surrounded by farm-land. Surface deposits in the cave appeared to constitute an owl midden, and this was confirmed by the presence on the floor of a nest of the barn owl, *Tyto alba*. Initial interest in the site came from the expectation of a sequence of avian remains that might reflect changing climate and/or vegetation cover. Subsequent excavation also indicated human occupation, so the cave was registered with the New Caledonian archaeological authorities as Site WMD007. The site was discovered in November 1994 and testpits excavated by JAGM the following August.

This paper reports on the human-related materials from the Mé Auré cave site. Apart from wood ash and charcoal (Grant-Mackie *et al.* 2003), and starch grains from cultivated plants (Horrocks *et al.* 2008), these consist of potsherds, a bead, a small piece of carved wood, human bone fragments, marine molluscs and crab chelae. Fish remains are also present, but have not been studied. Four rodent species, although possibly present only as accidental human associates, are included in this report because they are assumed to have arrived in company with humans. In addition, other animal remains within the cave have been previously reported and have revealed much of significance. The initial report, dealing with the general setting and herpetofauna, was presented by Grant-Mackie *et al.* (2003). Landsnails were documented by Cowie & Grant-Mackie (2004), plant food items by Horrocks *et al.* (2008), birds by Boyer *et al.* (2010), and bats by Hand & Grant-Mackie (2011) who record bones of the flying fox, *Pteropus ornatus*, as another likely human food item. So far, despite the coarse nature of the excavation, no other cave in New Caledonia has had its varied contents so extensively analysed, and the results from these studies should encourage the search in New Caledonia for further new data of cultural/historic significance.

The floor of the cave has an area of ~2.5 × 3.0 m with

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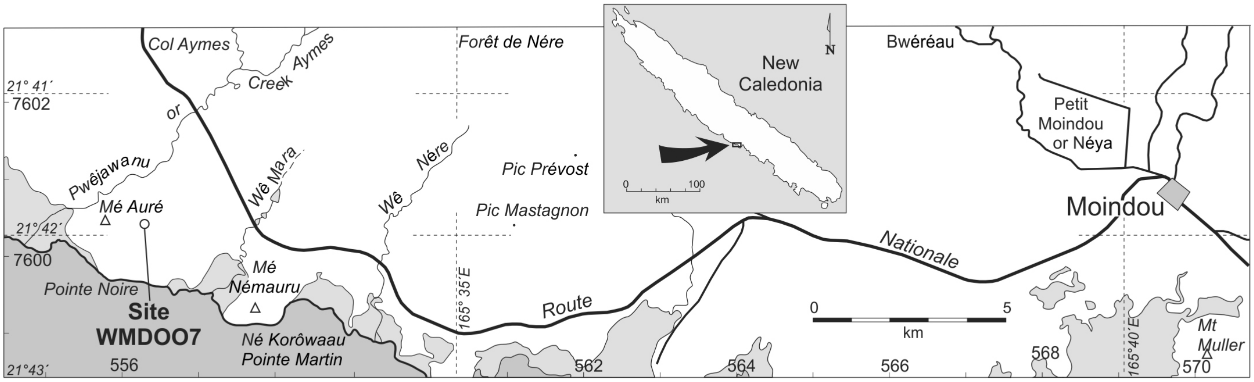

Figure 1. Locality map of Mé Auré cave (from Grant-Mackie *et al.,* 2003)

Figure 2. Site WMD007 (arrowed), viewed from the north, with Mé Auré (102 m) behind to the right (not to the left, as stated in Grant-Mackie *et al*. 2003, fig. 2).

the entrance on the southwestern side 2.5 m high and 3.5 m wide at the base. It was completely dry when first found but in August 1995 there was a small wet area beneath a fault-line (see description in Grant-Mackie *et al*. 2003). The floor was divided arbitrarily into segments (Figure 3) and excavation was confined to the southeastern quadrant (areas 1 and 3, Figure 3) after most of the loose surface material was removed (vertebrate and molluscan specimens collected, not discarded). The presence of fallen roof blocks made it very difficult to achieve a fine stratigraphic record. Divisions were based at levels formed by the fallen blocks and dictated by the location of larger rock clasts rather than by changes in matrix or stratigraphy, and consequently are rather coarse (Figure 4). The excavation went to 80 cm below surface level.

Material excavated, a mixture of sediment, modern plant remains, bones, shells, and pottery fragments, was sieved on site, using sieves down to 3 mm mesh. Sediment, fallen roof fragments and modern plant remains from the surrounding forest were discarded and the remainder bagged for transport. In Auckland these samples were sorted by biological group and sent to various specialists for study. The vertical ranges of deposit components are shown in Figure 5.

Pottery fragments and human bone from the excavation are held by the Institute of Archaeology of New Caledonia and the Pacific, Nouméa. The remainder of the collections are lodged with the fossil collections of the School of Environment, University of Auckland, catalogued using a running number and the prefix AU. They have also been included in the New Caledonia Fossil Record File, of fossil and 'subfossil' collections from New Caledonia held in New Zealand institutions, administered by the Geoscience Society of New Zealand and maintained by the Geology section of the University of Auckland School of Environment; each is identified by a running number prefixed with NC/f, and each NC/f number applies to all materials from one collection site. Where individual specimens

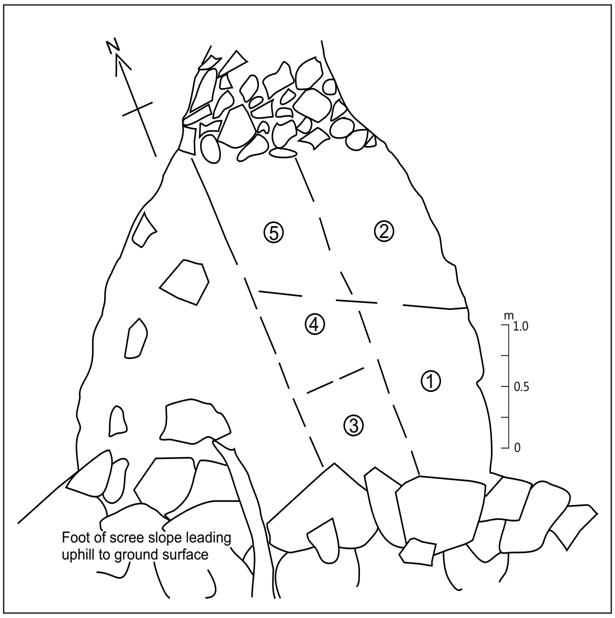

Figure 3. Plan of cave floor, entrance at the bottom of the diagram, showing fallen blocks of limestone, barn owl nest (dotted circle), part of the grid system used for excavation (straight dashed lines), and numbered collection areas (from Grant-Mackie *et al*. 2003).

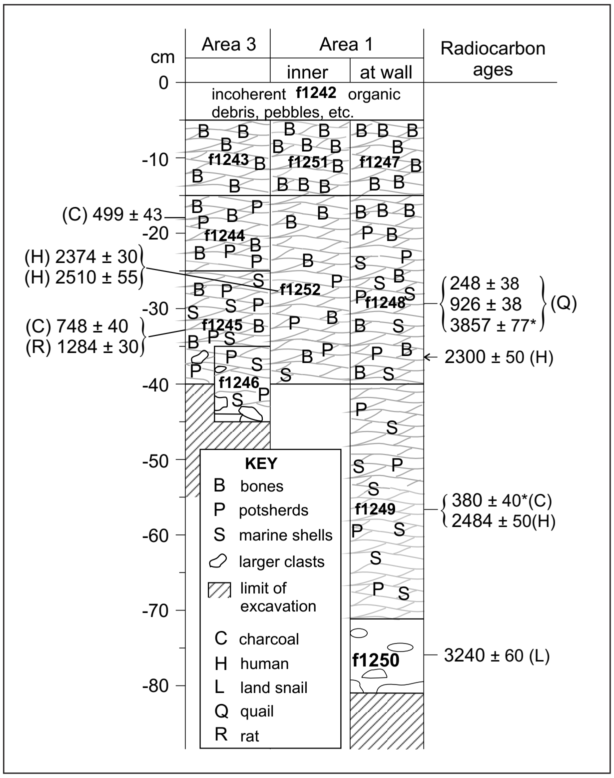

Figure 4. Stratigraphic column for areas 1 and 3 of Mé Auré cave, showing collection sites (f1243 etc., which should be prefixed with NC/ to give the full reference number), the distribution of various objects, and ^{14}C ages (from Horrocks *et al.*, 2008, and Boyer *et al.,* 2010). The 'lozenge' pattern denotes fine lenses of interbedded grey ash and charcoal, reddish soil, and shell and/or bone; small limestone clasts are ubiquitous and larger in the basal portion of area 1.

need to be identified they have been registered within the Catalogue of Type and Figured Specimens of the Geology section, with an alphanumeric consisting of a letter denoting the biological group (A for arthropod, V for vertebrate) and a running number. In the following account the NC/f... system is used, with AU numbers cited only to differentiate between collections with the same NC/f number; specimen numbers are used to refer to specific individual items. As this report deals only with materials from this cave, for the sake of brevity 'NC/' will be omitted in the citations in text and illustrations, but this prefix should be regarded as an integral part of the citation.

To establish a timeframe for the deposit a radiocarbon dating programme was undertaken, with samples processed by laboratories in New Zealand and North America (Grant-Mackie *et al.,* 2003; Horrocks *et al.,* 2008; Boyer *et al.*, 2010) (Figure 4). Although some anomalies and uncertainties exist, including inherent imprecision with some of the dated materials (e.g., *Placostylus* landsnail shells), JAGM believes some conclusions can be reached. The bottom of the excavation lies at ~3000 BP or a little less and the barn owl seems to have arrived in the area at ~2400 BP (for a discussion in particular of the questionable dates, see the first two references above). The coarseness of the excavation prevents detailed analysis of the age results, but Figure 4 suggests there are only two out of the 12 dates that clearly lie in anomalous stratigraphic positions (3857 ± 77 BP from a bird bone in the 15–40 cm range, and 380 ± 40 BP from charcoal in the 40–70 cm range) and the latter may be from a charcoal fragment displaced during excavation). Post-depositional disturbance seems certain to have occurred, as suggested by Valentin and Sand and by a few of the rodent occurrences (below), yet bedding has been reported as not extensively disrupted (Grant-Mackie *et al.,* 2003).

This final report on the material collected from the Mé Auré cave covers human and related specimens, *viz.* those associated with or resulting from the arrival and occupation or use of the cave by humans: human bone, potsherds, marine food items (molluscs, crabs, and fish), and rodents. Not to be forgotten also is the presence of bones of a fruit bat reported by Hand & Grant-Mackie (2011). One additional item, a wad of papery bark, was encountered but not retained, because its significance was not realised at the time of excavation. In the back half of area 2, in the northeast corner of the cave, the loose surface material was thicker than elsewhere, up to 20 cm. At

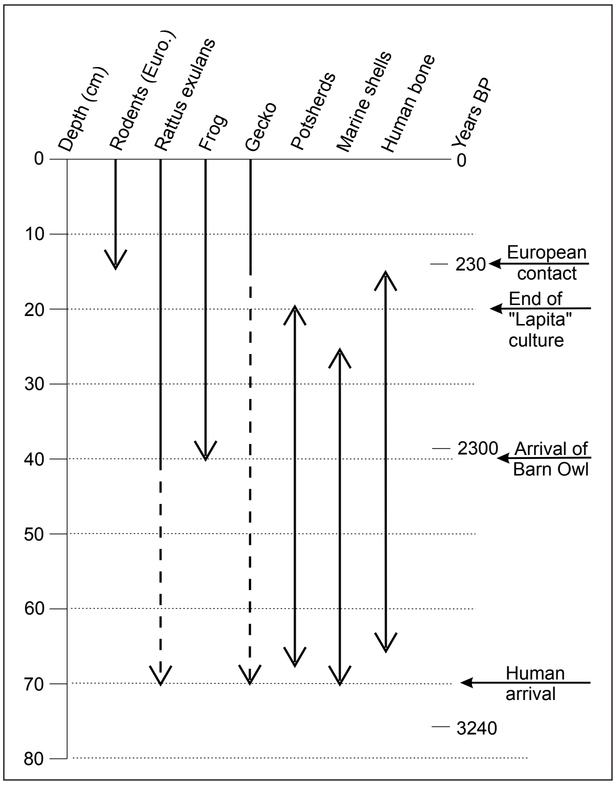

Figure 5. Stratigraphic distribution of organic remains and related materials and inferred events (Grant-Mackie *et al.* 2003)

the base of this loose debris was a wad slightly larger than a man's hand, ~20 × 12 cm, and ~3 cm thick, of dry niaouli bark (*Melaleuca quinquenervia,* the dominant savannah tree here) and grass stalks. In the context of the abundant wood ash and charcoal (no attempt was made to identify the original wood) this appears to have been a cache of fire starting materials gathered and carefully stored for future use in the driest part of the cave, then buried beneath the accumulating debris and forgotten.

1. ARCHAEOLOGICAL REMAINS (C. SAND)

Analysis of the archaeological material

Archaeological material from the Mé Auré excavation consists mostly of pottery sherds along with one shell bead and one incised wood fragment (Table 1).

Pottery

In total, 72 potsherds make up the collection. Amongst them, 21 sherds show surface weathering, possibly related to exposure and/or redeposition. The rest have a smooth surface, with a diversity of colours, ranking from light brown to black. A clear diversity of tempers is observable, with some sherds having only very fine sand grains while others retain coarser grains in their fabric. Clay diversity is observable, one sherd showing clear signs of foliation, indicative of poor quality clay. This diversity is also evident in variable chemical reactions during firing, some sherds having a black reduced internal colour with brown oxidised outer surfaces, while others have a uniform paste colour. This difference might also be indicative of a variety of firing processes. Slab building has been identified as the only construction method, no coiling joins being visible in the profiles. Most sherd thicknesses range between 5 and 7 mm, but range from a minimum of 2 mm (two sherds) to a maximum of 14 mm (one sherd) (Figure 6).

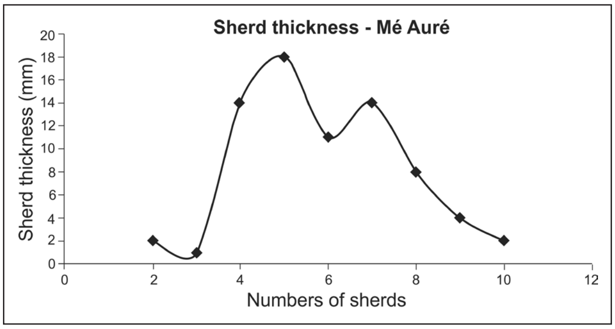

Figure 6. Diversity of sherd thickness, in mm, in the ceramic collection from Mé Auré.

These results indicate that most of the pots where thin-walled and consequently of a fairly small size. The three rims are all rounded and out-curved, two having an elongated lip, the last being shorter. Five very lightly angled shoulders (140–150°) have been identified, issued from a variety of pots (Figure 7). The main surface decoration, present on 33 sherds in total, is in the form of light paddle-impressions on a variety of pot types. Most printing marks are narrow parallel series of strips although some sherds bear larger and sometimes deep imprints characteristic of the late part of the Podtanean tradition produced in southern Grande Terre during the period 3000–2500 BP. The only other possible decoration is a set of bean-like oblique incisions that might be present on a small sherd, a type of decoration that is known on Puen-tradition pots, a ware produced between about 2500 and 1800 BP in the southern region of New Caledonia (Sand *et al.* 2011). A set of diagnostic sherds is presented in Figure 8.

Miscellaneous objects

Sorting of material from the upper layers of the cave floor (f1242) has revealed a small piece of wood 20 mm long and 2 mm thick, whose outer surface shows the remains

Table 1. *Summary of data on the ceramic collection from Mé Auré cave. Numbers in parentheses in column 2 show numbers of specimens showing weathering; those in column 3 show the total area of all sherds in each collection divided by the number of sherds in that collection; in column 6 numbers in parentheses refer to the proportion of each collection that bears paddle impressions; columns 4 and 7 show the numbers of sherds with rim remnants and with surface inclusions.*

Horizon	Potsherds (weathering)	Sherds surface (mean surface) (cm²)	Rim	Light carination	Paddle-impression	Incision
f1244	6 (2)	36 (6)	1			
f1245	7 (3)	30 (4.3)			1 (14%)	
f1246	8 (3)	60 (7.5)	1	1	6 (75%)	
f1248, AU14950	25 (9)	170 (6.8)	1	2	14 (56%)	1?
f1248, AU14949	1	16			1	
f1252, AU14953	6 (2)	30 (5)		1		
f1249	19 (2)	115 (6)		1	11 (57%)	
Totals	**72 (21)**	**457 (6.3)**	**3**	**5**	**33 (45%)**	**1?**

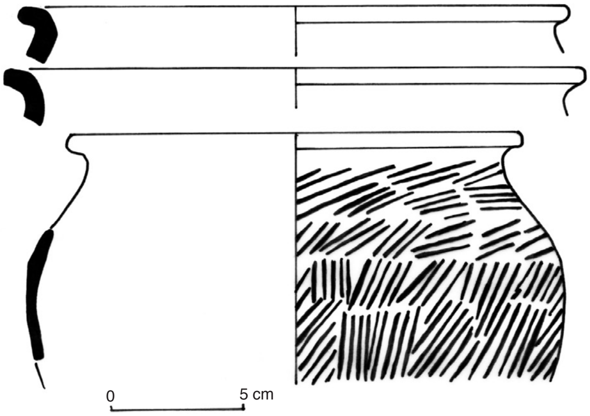

Figure 7. Tentative reconstruction of partial pot forms.

of incisions. The small size of the surface prevents any detailed reconstruction of the pattern, although the visible cross-hatched motif limited by two parallel incisions is a common Kanak pattern. The very fine incision might have been made with a rat-tooth, no stone implement probably being able to achieve such fine decoration (Figure 9, left image).

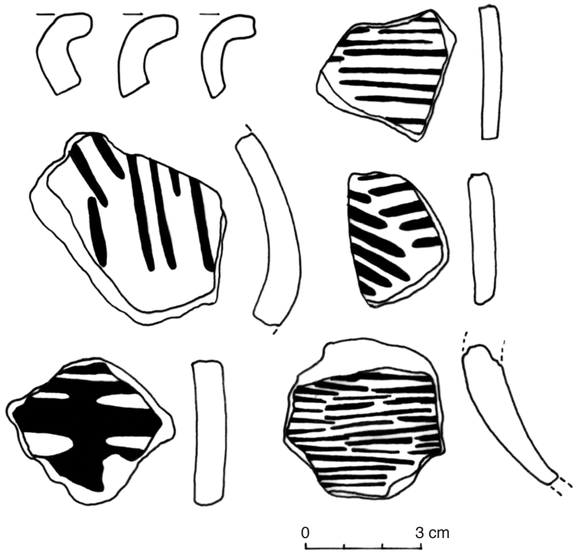

Figure 8. Examples of diagnostic sherds from the Mé Auré collection.

Figure 9. Non-ceramic objects from Mé Auré, wood sliver on the left, shell bead on the right. For dimensions see text.

The other manufactured objects discovered during the excavations (f1248, AU14950) include a round shell bead, 13 mm in diameter, with a central hole, possibly for a string. The bead section is not flat but waved, due to the natural form of the mollusc shell, probably a tonnid gastropod, from which the ornament has been manufactured (Figure 9, right image). In addition, note the record of a cache of dry niaouli bark etc. mentioned above.

The archaeological sequence and the Mé Auré site formation/occupation

This study of the archaeological assemblage enables confident identification of a collection of ceramics linked to the Podtanean and possibly the early Puen traditions of Southern New Caledonia. These pots were produced during the first part of the Koné period, roughly between 2750 and 2350 BP (Sand *et al.* 2011). They are characterised for the Podtanean tradition by lightly carinated pots of mainly small to medium sizes, with out-curved rims and non-organised paddle-impressions on all or some parts of the surface. Some of the early pots can be of high quality, with very thin walls. Towards the end of the Podtanean production period, around the middle of the third millennium BP in this part of New Caledonia, paddle-impressions become wider and more open, and occur on types of pots that are of mostly of medium thickness. At this time, production was of mainly non-carinated pots with more rounded or incurved rims, progressively decorated with different sets of incised and printed motifs of the Puen tradition. Over 45% of the sherds from the Mé Auré cave (by count) bear paddle-impressed marks, while only one possible sherd has an incised decoration. The few available rim-forms also point mainly to Podtanean pot-types, while the diversity of sherd thickness and paddle-impression marks indicate the presence, in this site, of productions spanning a couple of centuries, including late-Podtanean/early Puen types. But no pattern linked to excavation depth emerges from the study, early and late types being present together throughout the profile. Furthermore, about 30 per cent of the sherds bear signs of post-breakage weathering, indicating a high proportion of redeposition. The breakage pattern has also been examined: it shows no marked difference between the top and bottom of the excavation. The 40–70 cm horizon of Area 1 has a mean sherd size of 6 cm^2, similar to the combined area 3 material and lower than the upper horizon of Area 1, which stands at 6.75 cm^2. The combined figure of mean sherd size for the upper horizon is 6.45 cm^2 (Table 1). These results do not demonstrate any up or down movement of once *in-situ* pottery in the stratigraphy, but a statistically coherent set.

Questions have been raised, since the first publications from the Mé Auré site, concerning the stratigraphic coherence of the deposit. The set of radiocarbon dates presented in Figure 4, even leaving aside the land snail date which is known to give aberrant results (cf. Sand 1999), highlights the mixed nature of the stratigraphy. The results from the study of the ceramics come as a confirmation of this pattern in terms of absolute chronology. The vast majority of the sherds excavated in the cave can be securely dated between around 2750 and 2350 BP. Apart from f1244, 15 to 25 cm of Area 3, with a small corpus of 6 sherds without paddle-impressions (but with one out-curved rim), which could tentatively be used as a demonstration of the presence of ceramics linked to the second part of the third millennium BP (if the pattern is not a mere hazard), all the other horizons have decorated sherds. More significantly, not a single sherd can be ascribed to the Plum tradition of the second millennium BP, nor to the Nera tradition of the first millennium BP, whose difference from the Podtanean/Puen pot types can be easily recognized (Sand *et al.* 2011). If there had been a regular occupation of the shelter over a nearly 3000 year sequence, progressively creating the stratigraphy as some published interpretations of the radiocarbon results infer, these different pottery traditions should have been identifiable in one way or another. In the ashy deposit, not a single clearly identifiable fire-place appears to have been found, which would have been present in at least one of the horizons if there had been little stratigraphic mixing in the cave. Unlike many well stratified sites in New Caledonia (Sand 1995) there is no detectable pattern of chronological change from predominantly bivalve to gastropod shell-species in the site's fill (see Table 8).

The main reliance on *Strombus, Anadara* and *Gafrarium*, and the near-total absence of mangrove-linked oyster shells, is well in line with that expected for shell-gathering during the early part of the human occupation of the island in the Koné period (Sand 2010).

2. HUMAN BONE (F. VALENTIN)

Human remains[1] were recovered from both excavation areas 1 and 3 of Mé Auré cave, although mainly from area 1 which yielded 22 pieces from the 15 to 70 cm interval. A detailed inventory is given in Table 2. Considered globally, this assemblage consists of 23 fragments: eight cranial fragments, part of a tooth, two rib fragments, a capitate, a proximal phalanx of the hand, a metacarpal or metatarsal, a tibial fragment, five fragments of long bone, a cuboid, and two other fragments from the infracranial skeleton. There is no duplicating element, an observation supporting the interpretation that a single individual is represented.

The remains are all from an adult size individual. The absence of any trace of fusion of the coronal suture of the frontal fragment (in f1248) is an insufficient criterion to refine the age at death estimate. Similarly, the sex of the individual cannot be estimated because of the absence of sexually diagnostic criteria. Additionally, the bones do not show particular anatomical variation. The thicknesses of cranial fragments are not abnormal and there is a weak osteophytic ridge surrounding the calcanean facet of the cuboid indicating arthritis of the tarsus

With the exception of three intact bones of small dimension – cuboid, capitate, and proximal hand phalanx – the examined remains are all fragments. The maximum length reaches 258 mm in a single case (tibia from f1248 – Figure 10), the length of the other 21 lying between 8 mm and 74 mm, with a mean of ~37 mm. The fragments are generally elongated, with a width-length mean ratio of 0.61. Rib fractures are transverse; those of the long bones

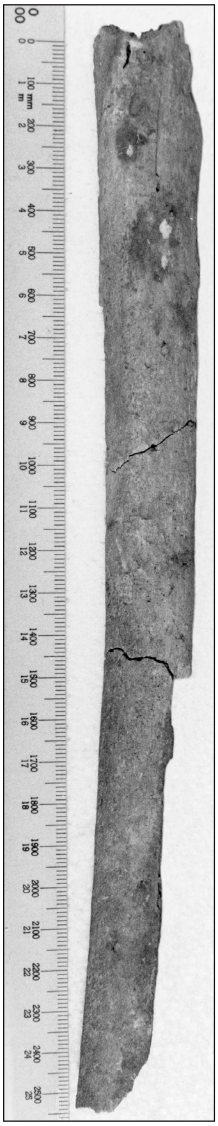

Figure 10. Fragment of human tibia from f1248, Mé Auré cave. This fragment, 258 mm long, was wholly destroyed to provide a radiocarbon date (2300 ± 50 BP – WK4521). 'Depth' is that below the cave floor.

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[1] The study was done in December 2003 within the former Archaeology Department (Service des Musées et Patrimoine de Nouvelle-Calédonie). The original report was in French (Valentin 2003) and part has been incorporated in this account, translated and abbreviated by JAGM and FV.

Table 2. *Inventory of the 22 bone fragments, presented in numerical order of 'f' numbers for the sites which have yielded them. None shows any special anatomical feature or paleopathologic lesion, except a cuboid, no trace of a cut or scrape or other sign of human activity, nor any rodent or other carnivore tooth marks. Traces of plant root activity can be seen on four specimens and evidence of fire is seen on eight others. Except where stated, no two fragments can be fitted together. Size in mm (length × breadth) followed by, in brackets, surface area in mm².*

Location	Identification	Size	Description	Modifications
f1245 (AU14948)	Supraorbital fragment of a frontal bone, medio-lateral region of the orbit, lateral supraorbital foramen present	22 × 10 (220)	vertical or oblique broken edges with irregularly jagged surfaces	dark grey/reddish brown coloration of exo and endo cranial surfaces
f1248 (AU14950)	Root fragment of a single rooted tooth, probably a premolar	8.3 × 3.6 (28.8)	transverse and straight breaks, with irregular edges.	deep reddish-brown
	Shaft fragment of a metacarpal or tarsal	9 × 8 (72)	transverse and longitudinal breaks	
	−15 to −40 cm. Infracranial fragment	14 × 7 (98)		
	Cranial fragment (frontal or parietal), including internal and external faces and diploe	18 × 17 (306)	oblique fractures	exocranial face & fracture edges with black/dark grey coloration; endocranial face deep reddish brown
	Left capitate	28.5 × 21 (598.5)	Complete; erosion of capitate tuberosity, on lateral face	
	Shaft fragment of femur or tibia	53 × 14 (742)	transverse and longitudinal breaks, stained and with irregular jagged edges	surface slightly eroded by dissolution
	Splinter probably from end of long bone (tibia or femur) or coxal (hip) bone	46 × 12 (552)	more or less oblique and incurved breaks with stained edges	
	Splinter of long bone	30 × 11 (330)		
	Splinter of long bone	36 × 13 (468)	transverse and longitudinal fractures with irregular jagged edges	
1248 (AU14949)	Frontal fragment, bregmatic region and right part of bone, including coronal suture	63.9 × 40 (2556)	rectilinear, vertical breaks with irregular edges, splintered, or incurved and oblique	
	Right parietal fragment*	62 × 35 (2170)	edges of breaks more or less regular and vertical or oblique, trace of root activity	reddish-brown coloration
	Right parietal fragment*	18 × 17 (306)	edges of breaks more or less regular and vertical or oblique	reddish-brown coloration
	Right parietal fragment*	54 × 34 (1836)	edges of breaks more or less regular and vertical or oblique	reddish-brown coloration
	Shaft fragment of tibia**	258		
f1249 (AU14952)	Fragment of right parietal from postero-temporal angle	33 × 25 (825)	rectilinear vertical or oblique edges with irregular jagged surfaces, trace of root activity	
	Fragment of right temporal corresponding to lateral sinus and including only internal surface	32 × 24 (768)	trace of root activity	
	Shaft fragment of long bone, possibly humerus	20 × 17 (340)	transverse and longitudinal breaks with stained and irregular surfaces	
f1252 (AU14953)	Fragment from infracranial skeleton	31 × 8 (248)		dark grey to blackish
f1252 (AU14954)	Right rib fragment, medio-posterior region	74 × 14.9 (1102.6)	transverse and oblique-transverse, with jagged edges, traces due to root activity	one end brownish
	Left (?) rib fragment	46.7 × 16.1 (751.87)	oblique fracture, with jagged and stained edges	
	Proximal hand phalanx	42.6 × 13 (553.8)		surface slightly eroded by dissolution
	Left cuboid	33 × 27 (891)		

* the three pieces fit together as one fragment 98 × 45 mm; ** used for radiocarbon dating, weighing 140 grams.

transverse or longitudinal. Edge surfaces are stained. Most are vertical and irregularly jagged, indicating, on the basis of Villa & Mahieu (1991) typology, that at least some of the fragmentation was produced on dry bones, long after body decomposition. The presence of some oblique and incurved breaks suggests also that certain skeletal elements were broken while some of the protein structure still existed, a condition that can persist long after the disappearance of the flesh. In the absence of evidence of deliberate action in bone reduction, such as percussion pits or flaking, other in-cave disturbances and reworking of natural and non-intentional human origins may have caused breakage of skeletal elements as well. Dispersal of the bone fragments across the cave filling, between 15 and 70 cm, supports this interpretation.

The natural surfaces of the fragments are generally well preserved. Some rare traces of plant root activity are present, but no intense weathering or animal gnawing. Furthermore they are all devoid of cut marks or traces of scraping. Eight fragments, representing 34.8 per cent of the assemblage and various parts of the skeleton (three cranial and two infracranial) have black to reddish-brown colouration from exposure to fire/heat. These fragments are either completely black or show a spot of localised heat but there is no evidence of calcination. Such a pattern suggests exposure to a low temperature poorly oxygenated fire. The pieces have edges with the same appearance as the unburnt fragments. They do not show the heat-induced changes, such as shrinkage, warping, transverse fracture with a curvilinear pattern expected when fleshed bones are burned through direct exposure (Buikstra & Swegle 1989). Such modifications are less variable and less frequent when dry bones are burned (Whyte 2001). Moreover, it seems that the action of the fire may have contributed to the Mé Auré bone fragmentation. The rupture of three cranial fragments from f1248, that re-assemble to form a piece 98 mm long, has occurred at a point of heat. Altogether, these observations suggest that the burning of the bones resulted more likely from accidental contact with fire, possibly during a phase of 'domestic' occupation of the cave, rather than from a deliberate cremation designed to separate body components. Cannibalism is also a less plausible interpretation, despite the fact that human remains from Pacific islands regarded as cannibalised are generally found in association with ovens or scattered in midden deposits (Best 1984, 2002, for a cave of the same time period). Of the nine features Storey (2008) associated with cannibalism only one (evidence of burning exceeding 10 per cent of the assemblage) and maybe a second (intermingling of faunal and human remains) are present at Mé Auré. However, these features need not directly relate to the body or bone treatment. In the Mé Auré context, they may also be explained by the other natural and cultural processes that have created the whole assemblage characteristics, including the human bone and pottery fragmentation and dispersion across the cave fill.

The presence of human bones in the Mé Auré cave fill appears therefore more likely related to a funerary event, representing the remains of a single individual inhumation, disrupted by later disturbance. The joint presence of cranial and infracranial parts of the skeleton (skull, hand, thorax, limbs, and foot, being represented) is interpreted as indicating a primary rather than secondary burial deposit. The small bones of the extremities generally are absent in secondary burials resulting from post-decomposition transfer of bones (Duday *et al.* 1990).

To summarise, the 23 human skeletal remains from Mé Auré cave, scattered across the excavation area, have been derived from a single adult-size individual represented by its cranial as well as infracranial skeleton, and show evidence of burning and fragmentation. Close observation indicates that the burning and fragmentation, as well as the dispersion, are not the final products of deliberate mortuary or non-mortuary activities aimed at disassembling the body components. They are rather the accidental, non-intentional by-products of other processes, of natural or cultural origins, that have affected an above-ground or in-ground inhumation performed in the cave. According to the results of four AMS direct dating on human bones (Horrocks *et al.* 2008), this funerary event/ceremony took place during the second half of the third millennium, around 2400 BP, corresponding to the Koné period (Sand *et al.* 2011) to which the potsherds recovered from the cave are also associated. Immediately post-Lapita period use of rock shelters or caves for mortuary activities, although known, is rare in the southern Melanesia region (Valentin *et al.* 2011, Ward & Houghton 1991) and the Mé Auré example appears to be the first identified in New Caledonia.

3. RODENT BONES (B. M. FITZGERALD)

After preliminary sorting of material from the cave by JAGM, rodent bones were sent to BMF for identification. Four species of rodent, the Pacific rat *Rattus exulans* (Peale, 1848), ship rat *Rattus rattus* (Linnaeus, 1758), brown or Norway rat *Rattus norvegicus* (Berkenhout, 1769), and house mouse *Mus musculus* Linnaeus, 1758, are known from New Caledonia (Nicholson & Warner 1953, Atkinson & Atkinson, 2000). All four are introduced species; *R. exulans* arrived with humans ~ 3000 BP or a little less, and the other three, cosmopolitan species, after 1774, with the first European contact with New Caledonia. The time of arrival of each of the cosmopolitan species is poorly documented; ship rats and house mice were reported as present by Revilliod (1913) and Norway rats not until 1944, when they were found mainly around human habitations (Nicholson & Warner 1953). Because the cave deposit has built up over several thousand years and rodents were by far the most abundant of all vertebrate groups represented in the collections, the depth at which a species is first recorded, and changes in the frequency of the species should reflect the major changes induced by events in human settlement of

New Caledonia, although the now well-established case for mixing cannot be ignored.

Methods

Five samples of ~ 200g each were taken from the unsorted surface layer and one sample of ~ 200g was taken from each of the lower sections of the cave deposit also before sorting. Long bones (femur, tibia, humerus, radius and ulna), the bones of the heel (astragalus and calcaneum), and teeth and associated bones were sorted from the samples and counted. Femora and humeri in which the epiphyses were fused to the shank of the bone were considered to have come from mature animals. For these bones the maximum femur length (MFL) (see Matisoo-Smith & Allen 2001, fig.3) and maximum humerus length (MHL) were measured using a graticule scale on a Zeiss Stemi 2000 stereomicroscope; the results were converted to mm. The femora and humeri of immature animals were identified to species on general dimensions (thickness *versus* length of long bones) and on the size of the head of the femur and the distal articulation of the humerus.

Mouse teeth were distinguished from those of rats by the notch on the upper incisors and by the presence of only three roots on upper molar 1 in mice. In rats upper molar 1 has five roots, a large anterior one and four smaller posterior roots. The position of the root cavities of upper molar 1 distinguishes *R. rattus* from *R. exulans*; in *R. rattus* the four posterior roots form a square, but in *R. exulans* the roots on the labial (outer) side are set slightly back from the lingual (inner) roots and form a rhomboid. Two measurements were taken on the upper molar root row (Table 3); 'A' is from the anterior edge of the first root cavity of molar 1 to the anterior edge of the first root cavity of molar 2; 'B' is from the anterior edge of the first root cavity of molar 1 to the anterior edge of the first root cavity of molar 3.

Table 3. *Measurements A and B on the upper molar row (see text for definitions) for three rodent species from the 5 to 15 cm level (f1247) and the 15 to 40 cm level (f1248) in Mé Auré cave, giving the means and standard deviations for each and the minimum and maximum lengths ('extremes').*

	M. musculus	***R. exulans***	***R. rattus***
Measurement A			
f1247			
Mean	1.853 (N = 5)	2.7 (N = 27)	3.032 (N = 10)
S. D.	0.069	0.165	0.197
Extremes	1.789; 1.972	2.477; 3.027	2.706; 3.257
f1248			
Mean		2.599 (N = 18)	
S. D.		0.12	
Extremes		2.385; 2844	
Measurement B			
f1247			
Mean	2.725 (N = 5)	4.257 (N = 27)	4.862 (N = 3)
S. D.	0.11	0.199	0.485
Extremes	2.615; 2.844	4.037; 4.826	4.312; 5.229
f1248			
Mean		4.16 (N = 13)	
S. D.		0.11	
Extremes		4.037; 4.404	

Counts are given here for various skeletal elements and teeth in surface material (f1242) (Table 4) to indicate relative proportions of the four species in the top 5cm of the deposit (i.e., over the last 200–300 years) as well as the relative numbers of different elements present in the sorted portions of the collections. For lower levels data for *R. norvegicus* are so sparse or actually absent that they have not been included in the tables. Data for these levels (Table 5) are presented for jaw and tooth counts.

Results

Remains of all four species of rodent (*Mus musculus*, *Rattus exulans*, *R. rattus* and *R. norvegicus*) were found in the

Table 4. *Numbers of selected bones and teeth of the four rodent species present in incoherent surface deposit (f1242) of Mé Auré cave to show minimum numbers of individuals represented.*

	R. norvegicus	***R. rattus***	***R. exulans***	***M. musculus***
Upper molar row	1R	9L; 12R	23L; 29R	17L; 19R
Mandible		11L; 14R	24L; 28R	20L; 26R
Humerus	1ad + 1juv	16L; 9R	29L; 25R	20L; 15R
Ulna		10L; 8R	17L; 25R	10L; 7R
Femur		52L; 34R	40L; 37R	13L; 37R
Tibia		25L; 31R	47L; 43R	22L; 28R
Calcaneum	1L	5L; 5R	5L; 8R (+1*)	2L; 3R
Astragulus		2L; 7R	6L; 2R	3L; 1R
Min. no. of indiv.	2	52	47	37

Table 5. *Measurements of selected teeth and associated bones (mandible and maxilla) of rodents present below the 5cm level of Mé Auré cave. Some teeth of R. exulans and R. rattus were unable to be distinguished and are listed under both as undifferentiated ('undiff').*

	R. rattus	***R. exulans***	***M. musculus***
f1247 (5 –15 cm)			
Upper incisor	47L and 50R undiff.		4L; 3R
Upper molar row	8L; 14R	46L; 47R	7L; 7R
Upper molar	2L; 6R	20L; 12R	3L; 6R
Lower incisor	15L; 11R	93L; 87R	51L; 51R
Mandible	14L; 14R	103L; 113R	61L; 57R
Lower molar	12L; 15R	72L; 82R	55L; 47R
f1248 (15–40 cm)			
Upper molar row	1L	18L; 23R	
Upper molar		7L; 8R	
Lower incisor		22L; 26R	
Mandible	2L	32L; 60R	1L
Lower molar	1L	25L; 44R	1L
f1249 (40–70 cm)			
Upper incisor	25L and 26R undiff.		1L; 1R
Upper molar row	1R	20L; 14R	1R
Upper molar	1L	19L; 25R	1R
Lower incisor	39L and 23R from all three species		
Mandible		32L; 25R	
Lower molar		32L; 30R	
f1244 (15 –25 cm)			
Upper incisor		7L; 10R	1L; 1R
Upper molar row		16L; 23R	
Upper molar		9L; 11R	
Lower incisor	31L and 26R undiff.		
Mandible		30L; 28R	
Lower molar		22L; 22R	
f1245 (25–40 cm)			
Upper incisor		7L; 16R	
Upper molar row		47L; 24R	
Upper molar		20L; 17R	
Lower incisor		22L; 18R	
Mandible		41L; 40R	
Lower molar		18L; 24R	

Table 6. *Mean, standard deviations and extremes (Min. = minima, Max. = maxima) in mm for adult femora and humeri of three rodent species from the incoherent surface layer (f1242) and the 5 to 15 cm (f1247) level in Mé Auré cave. R. norvegicus is not included because the only adult long bone of that species was the distal half of a broken humerus.*

	Mus musculus	***R. exulans***	***R. rattus***
Femur			
f1242 (0–5 cm)			
Mean	13.550 (N = 31)	23.639 (N = 46)	33.461 (N = 24)
S. D	0.624	1.078	0.869
Min. & Max.	12.5 & 15.2	21.8 & 25.9	31.3 & 35.5
f1247 (5 –15 cm)			
Mean	13.739 (N = 21)	23.577 (N = 22)	33.715 (N = 6)
S. D	0.720	1.343	1.174
Min. & Max.	12.5 & 15.2	21.4 & 25.9	32.1 & 35.5
Humerus			
f1242 (0–5 cm)			
Mean	10.959 (N = 14	18.321 (N = 21)	26.3 (N = 1)
S. D	0.660	0.693	
Min. & Max.	9.3 & 11.7	17.2 & 20.2	
f1247 (5 –15 cm)			
Mean	10.666 (N = 12)	17.160 (N = 25)	24.6 (N = 1)
S. D.	0.534	0.871	
Min. & Max.	9.8 & 11.5	14.9 & 18.3	

cave deposit, but *R. norvegicus* only in trace amounts. Measurements of long bones (femora and humeri) of mature rodents in the five surface samples (f1242) and in the underlying 5–15 cm (f1247) are given in Table 6. They separate out into three groups, representing *Mus musculus*, *Rattus exulans* and *R. rattus*. The largest of the femora and humeri of *Mus* are about five millimeters shorter than the smallest of these bones in the *R. exulans* group and the largest of the *R. exulans* bones are about five millimeters shorter than the smallest of the *R. rattus* bones (Table 6). In deeper samples, (f1244 and f1248), the mean length of the femora matches those of *R. exulans* bones in the samples at higher levels (24.396, 0.718, 23.3 and 25.6, N = 12, and 23.440, 0.634, 21.8 and 24.0, N = 17 respectively, compared with 23.639, and 23.577 in the top two layers) (Table 6). Thus, bones of adult rodents could be assigned accurately to species on size, and sufficient adults are present for the following analyses to provide realistic ratios of species present.

Measurements of the upper tooth row of *Mus musculus* do not overlap with those of *Rattus exulans* but the measurements of *R. rattus* and *R. exulans* overlap to some extent (Table 3). This may be, at least in part, because the samples included some tooth rows of immature animals. Therefore other features of the teeth, especially the notch in the upper incisors of mice and the shape of upper molar 1 of rats were used to separate the teeth to species (see Methods).

A high proportion of the rodent bones are from young animals, in which the epiphyses of the long bones have not yet fused to the shank of the bones. These span a wide range of sizes and have been assigned to species by either length, or width relative to length. The ratio of the number of femora or humeri from immature to adult animals is lowest in *M. musculus* and highest in *R. rattus* (Table 7). In some of the rat mandibles the third molar has not yet fully emerged. In surface sample 1 this is the case in 13.6 per cent of the mandibles of *R. exulans* and in sample 2 it is not fully emerged in 8.3 per cent of *R. exulans* and 7.1 per cent of *R. rattus* mandibles.

The species of rodent present in each layer of the deposit was determined; from the long bones of adults, from those of immature animals, and from the teeth. *Rattus norvegicus is* present only in trace amounts in the two top layers. However, the changes in the proportions of the four species are more difficult to determine. Femur and tibia yield the highest minimum number of individuals (Table 4). The variability in counts of the various elements of species other than *R. norvegicus* and in the proportions of bones of mature animals makes it impossible to give a definitive figure for the number of individuals of each species. However, *R. exulans* predominates to a greater extent in f1247 (5–15 cm) than in the surface layer (Tables 4, 5).

Discussion

The diet of barn owls in New Caledonia resembles that in Australia in the predominance of mammalian prey but is much more restricted in the range of prey available. Barn owls in Australia prey chiefly on mammals, especially native rodents including species of *Rattus*, *Notomys* and *Pseudomys,* and dasyurid marsupials including species of *Sminthopsis, Planigale* and *Antechinus.* Small numbers of bats, birds (mainly small passerines), reptiles and frogs also feature in the diet. Many arthropods are taken but form a very small part of the food intake (reviewed in Higgins 1999). On New Caledonia and adjacent islands the range of prey was very limited, comprising the four species of rodent, some bats, birds, reptiles and frogs. Boyer *et al.* (2010) identified bird bones from the Mé Auré cave deposit as being predominantly from small-bodied birds including representatives of 56 per cent of the living native New Caledonian landbirds and 76% of the bird species recorded in the area in 2004. Until the arrival of *R. exulans* there may have been insufficient suitable prey to support a permanent population of the barn owl, *Tyto alba.*

Table 7. *Numbers of left and right femora and humeri of adult and immature rodents in the surface material (f1242) and the 5 to 15 cm (f1247) layers.*

	Mus musculus	***R. exulans***	***R. rattus***
f1242			
Femora – adult	17 L, 20 R	28 L, 23 R	13 L, 14 R
immature	37 L, 47 R	129 L, 141 R	122 L, 95 R
% immature	69.4%	84.1%	88.9%
Humeri – adult	8 L, 12 R	9 L, 14 R	1 L, 0 R
immature	37 L, 30 R	73 L, 72 R	41 L, 43 R
% immature	77.0%	86.3%	98.8%
f1427			
Femora – adult	12 L, 12 R	14 L, 8 R	3 L, 4 R
immature	18 L, 25 R	127 L, 132 R	58 L, 51 R
% immature	64.2%	92.2%	94.0%
Humeri – adult	5 L, 7 R	12 L, 13 R	1 L, 0 R
immature	5 L, 6 R	62 L, 54 R	30 L, 32 R
% immature	47.8%	82.3%	98.4%

All four species of rodent recorded from New Caledonia were identified in the deposit, though *R. norvegicus* only in trace amounts. All species are recorded in the two uppermost layers (0–5 cm and 5–15 cm), but only *R. exulans* at lower levels. We consider that the few bones of *R. rattus* and *M. musculus* found below the 15 cm level were contaminants that fell unnoticed from higher levels during the excavation, or had moved down through crevices over time (see also Anderson *et al.* 2010: 107). The significantly increased abundance of ship rat and house mouse in the deposit above 15 cm and the general similarity in proportions of the species on the surface and in the deposit between 5 and 15 cm suggests the interface at 15 cm coincides quite closely with the arrival of Europeans and their rodents.

Rattus exulans does not appear in the excavation below the 40 cm level but as already stated by Grant-Mackie *et al.* (2003) this level is more likely to coincide with the arrival in the area of the barn owl, its use of caves such as Mé Auré as roost or nest sites and its exploitation of *R. exulans* as its major food source since, supplemented by other prey (frogs, birds, bats, geckos). The rat probably arrived much earlier, more or less coincident with the arrival of humans. Before the colonial era the owl preyed on the only rodent available, the Pacific rat, as well as on birds, frogs, and lizards.

Measurements for femora length of adult *R. exulans* from Mé Auré cave (means of 23.44–24.40 mm in the various samples) agree quite closely with the figure of 24.46 mm for mean femora length of adult *R. exulans* from archaeological sites in New Caledonia given by Matisoo-Smith & Allen (2001). Although they warned of the risk of misidentifying rodent bones because of overlap in the size of *R. exulans* and other rat species in the Pacific, at Mé Auré cave the femora and humeri of adult *R. rattus*, *R. exulans* and *M. musculus* do not overlap at all and are unlikely to be misidentified. However, on islands where other species of rats are present, misidentification of rodent bones may be a risk. The large spiny rat, *Rattus praetor*, has been found in archaeological sites on islands of the Western Pacific between 10°S and 20°S but is not known from islands further south, including New Caledonia (White *et al.* 2000). The measurements they give for femora and humeri of *R, exulans* from Vanuatu are smaller than those from Polynesia. The latter are close to our New Caledonia measurements and to those of Matisoo-Smith & Allen (2001). Femora and humeri of *R. praetor* from Vanuatu measured by White *et al.* (2000) fall between and overlap our measurements for *R. exulans* and *R. rattus.* Clearly, if bones of these three species were present together in cave deposits they would be difficult to differentiate correctly.

The bones of young animals are more difficult to identify than those of adults, and it is possible that a few of the bones of very young animals were misidentified to species. However, we are confident that most are correctly identified and, together with bones of adult rodents, well represent the proportions of the four species in the various levels of the deposit.

The high proportion of juveniles among the rat skeletal elements indicates that barn owls have selected juvenile ship rat, *R. rattus,* in preference to adults, and this parallels the prey choice of this species in Britain (Morris 1979). The implication of prey choice being governed by prey size is supported by the high numbers of mice remains compared with the rarity of the larger brown rat, *R. norvegicus,* rather than being a commentary on the relative numbers of prey animal species actually populating the area. In about ten percent of the rat mandibles from Mé Auré cave the third molar had not yet fully emerged. In a study of *R. rattus* in a New Zealand forest, young animals with teeth not fully emerged (tooth-wear age-class 1) weighed on average 42.6g (SD = 10.76, min. 24.3g and max. 59.0g). The predicted weight at which 50 per cent of animals were sexually mature was 100 g (Efford *et al.* 2006, BMF unpublished data).

Proportions of the four rodent species in the Mé Auré deposit differ markedly from those reported by Balouet & Olson (1989) from Gilles Cave, near Bouloupari some 40 km to the southeast of Mé Auré cave. The Gilles Cave deposit had two distinct layers, an upper layer 1.3m deep, containing bird and rodent bones derived mainly from barn owl pellets and a lower layer containing large numbers of lizard bones and some bird bones. In the upper layer bones of *R. norvegicus* are most abundant, bones of *R. rattus* and *R. exulans* are rare, and *Mus* is represented by but one bone. No rodent bones were found in the lower layer, and there was no suggestion of an intermediate layer containing bones of *R. exulans* without bones of the three cosmopolitan species of rodents. The cause for the discrepancies is unknown, but the preponderance of *R. norvegicus* in the upper layer may reflect greater availability of *R. norvegicus* and scarcity of *R. rattus*, *R. exulans* and *M. musculus* in surrounding habitat that differs from that at Mé Auré.

Other cave deposits have been excavated at Pindai caves northwest of Mé Auré (Anderson *et al* 2010). The caves had been used by humans and as a nesting/roosting site by barn owls. At Cave A, testpit 3, the bird bones have been identified to species but 'non-bird bones have yet to be enumerated' (Anderson *et al.* 2010: 95). *Rattus exulans* bones are present down to about 40 cm and *R. norvegicus/rattus* and *M. musculus*, along with the frog, *Litoria aurea*, only in the top 10 cm.

Material from a barn owl roost in a cave on Ouvea, in the Loyalty Islands, New Caledonia, has also been reported. *Rattus exulans* and *Mus musculus* are the only rodents present on Ouvea. The deposit of bones derived from barn owl pellets contained predominantly bones and teeth of rodents, but also included remains of an insectivorous mammal (presumably a bat), birds of several species, and one or two lizards. Bones and teeth of both *Rattus exulans* and *Mus musculus* were identified, and counts of femora indicated at least 80 individuals of *R. exulans* (89 per cent of them immature) and 13 *M. musculus*, of which only one was adult (92 per cent immature) (Robinet & Salas 1995, BMF unpublished data).

The forest remnant around Mé Auré is of dry sclerophyll type (Boyer *et al.* 2010), and this is a further reason for the rarity of *R. norvegicus* in our fauna, given that Rouys & Theuerkauf (2003) found them abundant in rainforest but less so in scrubland sites. On the other hand, although these authors noted that the house mouse was absent from shrubland, we found that it was common in the top layers in the Mé Auré cave, so the Mé Auré mice may have been caught at the adjacent homestead and farm area, or else the sparse dry coastal forest may be more conducive to mice than is the scrubland surveyed by Rouys & Theuerkauf (2003).

4. MARINE MOLLUSCS (J.A GRANT-MACKIE)

Marine molluscs, almost entirely bivalves and gastropods, are found only in the pre-European levels of the Mé Auré cave, associated with other human debris as well as with bird, rodent, bat, frog, and lizard bones, and land snails. Like some of the human bone, many have a grayish colouration indicative of slight calcining from proximity to fire. Almost none is unbroken and most belong to species collected for food. The few small specimens present can be interpreted as either accidental inclusions by adults or perhaps gathering by children mimicking their elders, and most are unbroken.

The fauna is not especially diverse (Table 8), reflecting perhaps reliance on a narrow range of abundant palatable species (possibly no more than 12 species). The table shows that most specimens are incomplete, a result generally of human predation. Gastropods generally have the outer lip broken back, or the body-whorl smashed, presumably in order to better access the soft parts, especially of *Trochus, Turbo, Tectus,* and *Strombus*. The shells of bivalves are often separated but unbroken, although many show chipping or breakage around the margins, where valves have been prised apart to access the flesh (*Anadara, Tridacna* and *Gafrarium)*. Most specimens are adult, but some subadult

Table 8. *Marine Mollusca present (22+ spp.) in the Mé Auré cave excavation, showing numbers of complete and, in brackets, fragments of each species in each collection. Species marked with an asterisk (*) are those regarded as likely contemporary human food sources (other possible food species, e.g., Ostrea, are represented by specimens too small in this collection to qualify as likely food). For bivalves, left and right valves are indicated; juv = juvenile specimen; op = operculum of gastropod.*

Species NC/	**f1244**	**f1246**	**f1245**	**f1248**	**f1249**	**f1252**	**f1251**	**f1243**
**Trochus niloticus* Linnaeus, 1769		(1)	(1)		(1)			
**Tectus fenestratus* (Gmelin, 1791)					(2)			
**T. ?mauritianus* (Gmelin, 1791)					(1)			
**Turbo argyrostomus* Linnaeus, 1759	op, 2	(2)				op, (2)		
Pilesabia trigonia (Gmelin, 1791)							juv	
?Neritacea			(1)					
Cerithium trailli (Sowerby, 1855)	juv							
?Cerithiidae	(1)		(1)			(1)		
Cypraea moneta Linnaeus, 1758			1					
C. tigris Linnaeus, 1758						(1)		
**Tonna ?olearium* Linnaeus, 1758		(1)			(1)	(1)		
**Strombus luhuanus* Linnaeus, 1758		2 (14)	8 (1)		(9)	(5)		
Gastropoda	(1)	(1)	(1)	(1)		(1)		(1)
Dentaliidae						2		
**Anadara scapha* Linnaeus, 1758		(R, L)	2R, 2(1)L			7(1)R, 4(1)L		
Modiolus cf. *areolatus* Gould, 1850					(R)	R		
?*Ostrea cucullata* Born, 1778					2 juv			
**Tridacna maxima* (Roding, 1798)		(1)	(2)			(R), 1(1)L		
**Polymesoda (Geloina) erosa* Solander, 1786		(R)				(R)		
?*Gari* sp.						(L)		
**Gafrarium pectinatum* Linnaeus, 1758		L	(R)		L	L		
**G. tumidum* (Roding, 1798)		R(R), 2(1)L			2(1)R, 2L	3(1)R, L		L

and juvenile shells are present. Molluscs are most abundant in collections f1245, f1246, f1249, and f1252 and occur more rarely in four other collections (Table 8), with none present in f12476 or in collections from the top 5 cm (f1242). This latter fact, together with the absence of ash and other evidence of fire in the surface layer, strongly suggests that the cave has not been used by visiting Kanak people during most of the European era.

The most abundant species are *Strombus luhuanus* (39 shells), *Anadara scapha* (20 valves), and *Gafrarium tumidum* (16 valves). All other species listed in Table 8 are represented by fewer than 8 specimens, and 10 species are known from only one or two shells. At the time of early European contact it is clear that a wide range of marine molluscan species were taken for food (e.g., Sand 1995, 2001).

The complete absence of oyster shell, apart from a single find of two valves, one cemented to the other and both less than 10 mm long, is notable, especially considering that the adjacent shore includes rocky outcrops and mangroves ideal for oyster attachment. This might indicate that, during the main occupation of the shelter, the coastal area near Mé Auré was somewhat sandy – a hypothesis well in line with the results from study of archaeological remains (see Sand 2010). Similarly, the absence of adult mussel shells is surprising, although even at the present time mussels are far from a prominent element of the coastal fauna in this vicinity.

Marine molluscs have also been reported from Gilles cave, ~40 km to the southeast. Balouet & Olson (1989: 4) comment that "shells such as *Arca, Ostrea,* and *Nautilus,* assumed to have been brought in by man, were fairly common throughout the deposit". The first-named is probably more correctly *Anadara,* as in our lists, since there is no local *Arca* of value as human food.

5. CRAB REMAINS (B. RICHER DE FORGES)

Introduction

Crustacean biodiversity in New Caledonia is very high. Several thousand species are present, including more than 500 species of crab (Milne-Edwards 1872–1873; Ng & Richer de Forges 2007). Crabs have a calcified carapace hard enough to be readily fossilised, and fingers (dactyli, or parts of the propodus) of the chelae (pincers) are the most robust part, very resistant, and commonly found in lagoon sediments or in the regurgitated pellets of sea birds. Identification of crab species from chelae fingers alone has proven to be quite difficult, but not impossible.

Method

Dry crustacean remains were found in nine of the sample sites in the Mé Auré cave. All consist of fingers of crab chelae. All specimens were identified from the reference collection held in the Queensland Museum.

Results

The samples generally show enough characters of the chelae to identify them at least to family level (Table 9) and in one case allowing specific identification. The crab families Portunidae, Xanthidae, and Grapsidae are represented. In two samples there are in addition the chelae of hermit crabs (*Dardanus*).

Many of the fragments show the creamy white colouration of bleached carapaces, but some are shades of grey as a result of slight calcining from proximity to fire. Most of these scorched fingers belong to *Scylla serrata*. There are seven in f1243, all *Scylla,* another seven fragments in f1247, mostly *Scylla,* one or two in f1251, also both *Scylla,* and a small finger of *Thalamita* sp. B in f1252. The lack of evidence of more extensive burning suggests that the crabs were not generally cooked by simply putting them on a fire.

Table 9. *Identification of crab chelae from Mé Auré cave and localities from which they were collected.*

NC/F....	*Thalamita* sp.A	*Thalamita* sp.B	*?Etisus sp.*	*Scylla serrata*	Grapsidae indet.	*?Sesarma*	*?Portunus*	*Dardanus*
1242	x			x			x	
1243	x			x			x	
1245			x					x
1246				x				
1247	x		x	x	x			
1248	x		x	x		x	x	
1249	x		x	x		x	x	
1251	x						x	x
1252		x						

The presence of crab remains in deposits of the European era, in the absence of other evidence of human use of the cave in this period, may be an indication of reworking from lower levels or of owl predation on crabs.

Comments.

The crabs identified are mainly of larger sized species, some of them edible by humans (especially *Scylla serrata*). All these animals live today along the modern shore in very shallow waters. The portunid crabs, *Thalamita* spp., *Scylla serrata,* and ?*Portunus* sp., are swimming crabs (Figure 11, No. 1–3), living in mangrove or seagrass beds. *Scylla serrata* is a big species which can reach more than 15 cm wide and more than 1 kg weight for adult males. It is a species of commercial interest today in New Caledonia and more widely in the Indo-Pacific, the crabs being taken in their mangrove mud burrows today by Melanesian women (Guinot 1967, Delathiere 1990).

Xanthid crabs are more frequently found in rock and coral habitats. This species (?*Etisus* sp., or *Phymodius* sp. Figure 11, No. 6, 7) has a very characteristic horse-shoe shaped cheliped. Some species of *Etisus* are edible. Grapsids (Figure 11, No. 4) live in the upper littoral area, on rocks or mangrove roots. The hermit crab (*Dardanus* – Figure 11, No. 8, 9) is a littoral species.

Among this fauna, only two species are frequent in this material: *Thalamita* sp. A constitutes 58 per cent of faunas in collections in which it occurs, and *Scylla serrata* forms 50 per cent of the crab specimens in collections containing it.

Conclusion.

The more numerous fragments from large edible crab species are probably remnants of the human diet of this area and are found in the cave deposits as a result of eating them there. The few remains of smaller species could have been brought into the cave as a result either of less selective gathering of food, i.e. in the process of deliberate food gathering by adult humans, or by children, or they could possibly represent an occasional part of the diet of the owls occupying the cave. All these species could be collected along the shore at low tide today, without the use of a boat.

6. FISH BONES (J.A. GRANT-MACKIE)

Scattered isolated fish bones were rare but widespread in all layers except f1250 (pre-human) and a few pockets of fish scales and a solitary otolith were also extracted. The bones are small to very small, generally no longer than 20 mm, the largest being a rib 78 mm long (from f1246). Vertebrae are the most common skeletal element. The assemblage includes very few skull, jaw or opercular elements, the paucity of which may indicate that the fish were

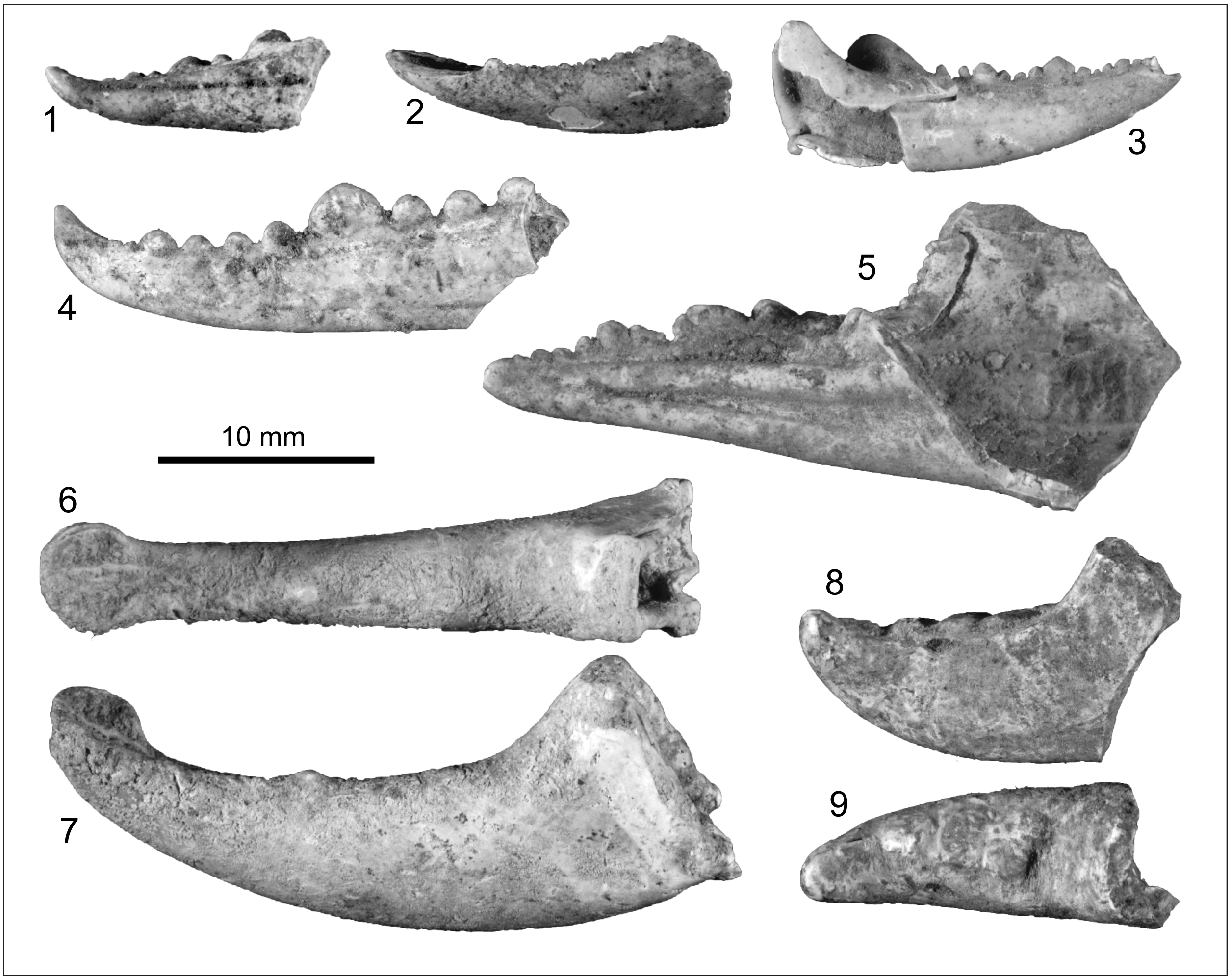

Figure 11. Examples of the mobile fingers of crabs from the Mé Auré excavation, in lateral and (for 6 and 9) ventral views. 1: *Thalamita* sp. A, A525, from f1251. 2: *Thalamita* sp. B, A526, from f1252. 3: *?Portunus* sp., A530, from f1248. 4: Grapsidae indet., A528, from f1247. 5: *?Sesarma* sp., A529, from f1248. 6, 7: *?Etisus* sp., A527, from f1249. 8, 9: *Dardanus* sp., A531, from f1245. Scale bar is 10 mm.

generally decapitated at the coast before being brought to the cave, or else cooked in such a way as to enable thin plate-like bones to be consumed (a procedure seen in New Caledonia today and widespread in Southeast Asia and the Pacific – JAGM, pers. obs.). These remains have not been further studied, but the collection probably represents the remains of small in-shore fishes.

SUMMARY AND DISCUSSION

As this concludes the study of the contents of Mé Auré cave it is appropriate to summarise the findings. The results are significant firstly because they constitute the first comprehensive study of a New Caledonian cave excavation, secondly because the materials include both human and owl midden deposits, and thirdly because various new conclusions can be drawn despite the coarse level of sampling undertaken, which undoubtedly could have been improved had the presence of the human-derived material been anticipated before excavation commenced. In addition, however, the study again emphasises the value of interdisciplinary collaboration. Attempts at establishing a radiocarbon age framework were inconclusive and have led to differing views among the authors.

It should be noted that the coarse sampling pattern has meant that samples, as shown by AU and NC/f numbers, represent up to 30 cm of strata (f1249, Figure 4) and that items selected for dating may have come from any level within the interval covered by the sample. The pointers on Figure 4, linking dates with individual sample locations, are intended to show from within which sampling site the dated items came. (In the case, for instance, of f1245 or f1252, each with two dated items, the items may have occurred in the deposit in the stratigraphic order indicated by the dates, and there is no evidence for or against this interpretation). If one accepts that the dates do represent the stratigraphic order, then there exist only two anomalous dates. Only another dating programme using much more closely stratigraphically constrained objects can solve this problem.

CS rejects, on archaeological grounds, the interpretation of this site as a multi-occupational camp for human use. The conclusion he favours, pending finer-grained excavations, is that the deposit is mixed, through low-scale multi-secular processes as well as heavy climatic events like cyclones and some in-wash from up-site. The type(s) and frequency of the damage caused by other phenomena like the reworking of layers linked to large banyan tree roots, is difficult to define at present with any confidence, as the crude nature of the excavation and the absence of a detailed recording of the succession of layers/lenses prevent any easy understanding of the sedimentary processes. Alternating layers of 'dark and light gray' and 'red-brown colour' lenses described by Grant-Mackie *et al.* (2003: 296), would signal different episodes of formation and redeposition, mixing archaeological material and soil with bones coming mainly from barn owl pellets.

These conclusions are judged by JAGM to be too severe, although there can be no doubt that the sequence has been disturbed by human agency and that earlier conclusions must be reconsidered. From his observations, root disturbance has been minimal, with only young roots and rootlets (up to ~ 3 mm diam.) seen within the sediment during excavation; their presence has certainly not significantly disturbed the gross stratigraphy and can be ignored as a significant force in strata disruption. With the site being near the top of the rise the amount of likely inwash even in a severe storm is unlikely to have been great and probably consisted mainly of leaves and twigs. Soil development or accumulation within the cave was also minimal; the sequence was dominated by ashy layers with charcoal and no evidence of mass-flow soil deposits as might occur during a major storm event.

The study of the archaeological material retrieved from the excavations of Mé Auré cave shows that possibly the entire set of potsherds is linked to a production of Podtanean/early Puen vessels, datable between around 2750 and 2350 BP. No internal typological or chronological differences can be observed between the artificial horizons, and no later types of pottery have been identified. This result raises doubt about the un-mixed nature of the deposit emphasized in earlier publications and it urges instead the conclusion that the Mé Auré stratigraphy consists mostly of a redeposited set of horizons. If this conclusion is correct, interpretations already published relying on a fixed chronology, especially about vegetation change and avifauna depletion (Boyer *et al.* 2010) or early aroid introduction (Horrocks *et al.* 2008) will need to be revised – but note the ubiquitous occurrence of the aroid remains.

There is apparently incontrovertible evidence for partial post-depositional mixing of some horizons, especially in the spread of human bone through 50 cm and of Podtanean/early Puen potsherds through a similar thickness of the deposit. That this mixing occurred in pre-European times is substantiated by the absence of European rodent species below 15 cm.

Despite the present work showing clear evidence of disturbance and mixing of sediment within the cave, which had not been suspected from the earlier studies, results do include useful and significant conclusions. The following are worthy of emphasis.

Even allowing for the lack of precision in dating landsnails from limestone caves, the Mé Auré record covers, perhaps discontinuously, some 3000 years of accumulation up to the present. The oldest part of this record (f1250) appears to pre-date the earliest human use of the cave and confirms the landsnail *Placostylus duplex* as a pre-human endemic of New Caledonia.

The upper levels, down to 15 cm, seem undisturbed and to record the period from initial European contact, shown especially by the almost complete restriction of the abundant bones of European rodents to this zone. Furthermore, human bone and potsherds are absent in this part of the sequence. European rodent remains and potsherds and human bone do not overlap in the stratigraphic record, as could be expected from complete post-depositional mixing.

The restriction of small bones – rodents, birds, bats, lizards, frogs – to levels above 40 cm (f1245, f1248, f1252) is taken to indicate the arrival of the barn owl, *Tyto alba*, in the area at the time represented by that level (~ 2300 BP), all of these species having been prey items. The rare presence of *Rattus norvegicus* in the two top layers (i.e., down to 15 cm at most) is a clue to its possible arrival earlier than the record of Nicholson & Warner (1953) but its numbers are not sufficient for a firm conclusion.

One of the important conclusions of an earlier study was that the East Australian green and gold frog *Litoria aurea* must have been present in New Caledonia in pre-European times, because of the abundance of its bones in the lower part of the sequence, and is likely to have been introduced from Australia by the indigenous people of one or the other area, rather than by Westerners in later times (Grant-Mackie *et al.* 2003). The above conclusion that the deposit was undisturbed in post-European arrival times coupled with the abundance of frog bones in the pre-European levels gives some additional support to a pre-European introduction. Other evidence for this is presently scarce or non-existent.

Amongst the bird bones (Boyer *et al.* 2010), more than half the bones of the barn owl, *Tyto alba,* are juvenile and this demonstrates the high juvenile mortality as well as giving firm evidence that owls nested in the cave and for the bone deposit to have resulted mainly from owl predation. Analysis shows also that during the colonial era the owl rarely predated *Rattus norvegicus,* and chose instead the smaller *R. exulans* and *R. rattus,* and, almost as often, *Mus.*

Given the stratigraphic sequence, with the apparently continuous presence of small bones through the top 40 cm, with the less continuous distribution of ash and other evidence of human use, it seems that perhaps use of the cave by owls was more constant than that by humans, the latter's presence being perhaps only episodic. Had human presence been more frequent the owls would have returned less frequently or abandoned the cave entirely.

Thus we get a picture of people coming probably from inland settlements, gathering food beside the lagoon (molluscs, crabs, fish), stopping at the cave to build fires to cook and eat, maybe also catching fruit bats and Pacific rats, before returning home. The visits must have been seldom enough for owls to nest there, leave when disturbed, and then return to nest. Nesting continues there today.

Future excavations, as well as more extensive analysis of collections from other sites, should throw more light on species represented by incompletely identified remains of lizards (Scincidae – Grant-Mackie *et al* 2003), birds (e.g., *Colocallia* sp., *Zosterops sp.* – Boyer *et al.* 2010*),* bats (*Pteropus* sp(p)., Hipposideridae – Hand & Grant-Mackie 2011), and landsnails (*Pleuropoma* sp., *?Microcystis* sp., *Pararhytida* sp.– Cowie & Grant-Mackie 2004), and thus extend our knowledge of the fauna of New Caledonia. More detailed excavation may also determine the order in which the European rodents invaded and how rapidly they spread throughout New Caledonia, identify fire-places, and clarify the issue of stratigraphic disturbance.

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