OWL PELLET REMAINS IN NEWDEGATE CAVE (H-X7) SOUTHERN TASMANIA

By Arthur Clarke

Introduction:

Mammalian skeletal remains (commonly referred to as sub-fossil deposits) are frequently found in caves, particularly in those caves with vertical or sloping entrances and/or large rift entrances, where the caves act as pitfalls or "mammal traps", but may also contain skeletal remains of other vertebrates: reptiles, amphibians and birds. The skeletal bone pieces are usually whole pieces, though often dismembered and scattered, and the soft-boned skull fragments are often found close to or intact with their harder-boned mandibles (jawbones). Identification of this skeletal material is useful because it can provide an indication of the present day (and past) distribution of vertebrate species (including extinct species and macro-fauna) in any given locality. In some caves which have relatively large vertical or rift entrances, floor deposits in the entrance series of passages may contain the accumulated skeletal remains of small mammal species, mainly composed of whole bone pieces such as skulls, mandibles and leg bones; these accumulations often represent the remains of owl pellets.

Owls are known to roost in caves; as creatures of habit, they regularly roost in the same locations on sheltered ledges high up in avens, shafts or vertical rifts inside the darkened cave entrances. Owls tend to only use undisturbed cave sites that are not regularly frequented by other (human) cave visitors. While roosting in caves (and barns etc.), owls regurgitate "pellets" of indigestible material: "scrunched up" and whole (intact) bone pieces and fur, which over time form as small heaped piles or mounds on the cave floor directly beneath their roost (**Clarke, 1988**). Owls are included amongst the raptors: birds which prey on small mammals such as rodents and antechinus, as well as other smaller birds, frogs, lizards and some invertebrates, mainly spiders and large beetles. Some owls are known to prey on larger mammal species, usually immature species, including brushtail and ringtail possums, quolls and rabbits (**Hall, 1975; Hollands, 1991; Mooney, 1993**). Many of the owl pellet accumulations of small mammal bones in caves, represent the remains of past activity by owls that frequented caves and cave entrances, possibly many decades or even centuries ago (**Bowdler, 1984; Hall, 1975; Hollands, 1991; Wakefield, 1969**).

There are only three or four active owl roost sites in Tasmanian caves, known to the writer at time of presentation of this paper; all of these are located in forested karst areas of southern Tasmania: in the Cracroft, Ida Bay and Precipitous Bluff karst areas. However, there is evidence that caves have been previously used as owl roosting sites in several other caves in Tasmanian karst areas, including Bubs Hill, Hastings, Junee-Florentine, Mole Creek and Mount Weld (see Figure 1).

It is quite likely that there are other owl roost sites in Tasmanian caves and karst areas, particularly in the forested regions that owls, such as the Tasmanian Masked Owl (*Tyto novaehollandiae*), are known to frequent. One of these presumed past owl occupation sites includes Newdegate Cave (H-X7): the present tourist cave in the Hastings karst area of southern Tasmania, where the writer has been recently engaged in collating an inventory of the cave dwelling invertebrate species. Many of the small mammal bone fragments found in Newdegate Cave have been fractured or broken, probably subsequent to deposition.

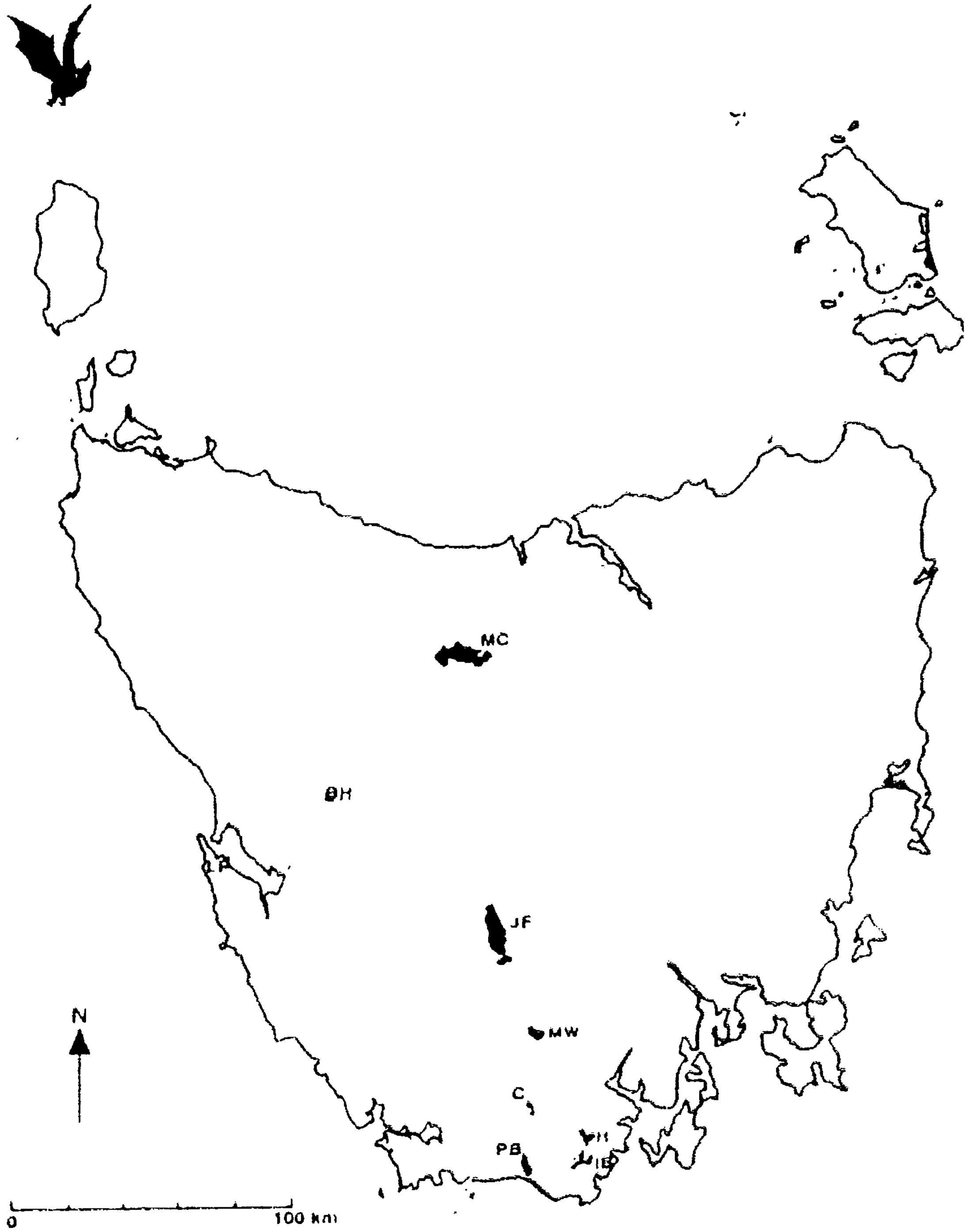


Figure 1: Map of Tasmania showing location of the eight karst areas with the records of caves containing owls or owl pellets (as discussed in this paper). The karst areas are shown by their respective ASF Cave Area codes: BH = Bubs Hill, C = Cracroft, H = Hastings, IB = Ida Bay, JF = Junee-Florentine, MC = Mole Creek, MW = Mount Weld and PB = Precipitous Bluff.

The formation of owl pellets:

The avian (bird) stomach consists of two parts: the first (top) stomach is a glandular organ with enzymes, where most initial digestion takes place; the second (bottom) stomach is a muscular organ, sometimes referred to as a gizzard. In fowls, this second stomach, which is sometimes referred to as the "crop", acts as a grinding organ to mash up the partly digested and softened seed grains, grit and other foodstuffs. In raptors, such as owls, this second stomach acts as a filter, holding back the insoluble food substances such as bone, teeth, claw-tips, fur, feathers, the chitinous exoskeletons of insects or spiders and sometimes cellulose (Hall, 1975; Mooney 1993).

Most animal species have the ability to selectively choose which parts of a food source they wish to consume. Many bird species, including some raptors, can use their beaks or claws to separate seeds from husks or flesh from bone, but owls can only roughly tear their prey apart and tend to swallow their prey food whole. During a breeding season, when there are young owl chicks in the nest, owls will often decapitate their prey and swallow the heads whole, bringing the remaining body back to the nest for the chicks (**Hollands, 1991**). Following initial digestion in the glandular stomach, the remaining indigestible foodstuffs including skull, mandibles (jawbones or dentaries) and other bone parts accumulate in this second filtering stomach (or gizzard) where it is compressed into the shape of the gizzard, coated in mucous and regurgitated as a pellet while the owl is roosting. Owls will usually regurgitate at least one pellet a day, sometimes two or more depending on the species, their prey foraging habits and success rate of prey capture. The *Tyto* species of owls usually only regurgitate a single pellet each day, regurgitated at their favourite roost place: their pellets tend to be highly compressed and are usually much more durable (**Hollands, 1991**).

The importance of cave sites:

In a forest habitat, the owl pellets are dispersed quite rapidly, by bacteria, insects, fungi and marauding scavengers including other mammals and birds. In caves, the pellets tend to be well preserved, possibly due in part to the presence of a moist calcareous environment. In dry caves where there are often less bacteria or insects compared to more moist cave environments and epigean (surface) habitats, the pellets may retain their shape for several months and the component parts including fur and feathers may remain unchanged for many years (**Hollands, 1991**). Over time, these single individual pellets found in caves may coalesce to form a large accumulation mound, which may represent a considerable period spanning several decades or centuries (**Clarke, 1988; Hall, 1975**) or many thousands of years (**Wakefield, 1969**). An owl pellet accumulation from Cave Bay Cave on Hunter Island in north-western Tasmania has been dated back to late Pleistocene times, *circa* 19,000 years BP (**Bowdler, 1984**).

Caves are important for several other reasons:

- They provide an excellent site for researchers (zoologists or speleologists) to study recent owl pellet remains or the long term older accumulations;
- The pellet sites can yield information of other animal species within the 1-2 kilometre foraging range of owl roosts, particularly extant (living) mammal species that may not have been seen during routine trappings or observations by zoologists (**Clarke, 1987b; 1988; Hall, 1975; Hollands, 1991; Mooney, 1993**);
- The deposits can provide information on the availability of prey food, food preferences or dietary selection over a given period of time (**Mooney, 1993**);
- Owl pellet deposits can provide records for extant mammal species that may be no longer known or recorded in that particular geographic area (**Hall, 1975; Mooney, 1993; Wakefield, 1969**);
- The larger or deeper (older) accumulations often contain records of extinct species, either from recent decades, last century or pre-European settlement (**Hall, 1975; Hollands, 1991**), or dating back to pre-historic times in the Pleistocene era (**Bowdler, 1984; Wakefield, 1969**);
- Older deposits may be important sites for age determination (using bone carbon or charcoal) for dating the occupation by owls in those caves (**Bowdler, 1984**);
- An analysis of the species types and food selection in the older deposits may also provide speculative or actual information relating to vegetation or climatic change over a period of time, plus the possible anthropological effects of aboriginal or European man on native fauna (**Bowdler, 1984; Wakefield, 1969**);

- The presence of larger disused or abandoned deposits at the base of avens or cave chambers may also be important as a geomorphic tool, providing a useful indicator to the likely presence of previous cave entrances that may have become subsequently blocked by surface tree fall, doline or cave entrance collapse or the more recent deposition of speleothems.

In the paper presented by Les Hall (to the 10th ASF Biennial Conference), where he compares his work in Marble Arch with the results of excavations in Pyramid Cave at Buchan (**Wakefield, 1969**), Hall has identified some 23 mammals, based on his detailed excavation of owl pellet accumulations at Marble Arch, 60km southeast of Canberra (**Hall, 1975**). A similar number of mammalian species were determined from the bone accumulation in Cave Bay Cave on Hunter Island (which is presumed to be a combined peregrine falcon deposit in Holocene times and an owl pellet accumulation during the Late Pleistocene); this latter deposit is dated 19,000 years BP (**Bowdler, 1984**). In the more recent 1989 paper by Nick Mooney, where he details the past and present diet of the Tasmanian Masked Owl, he lists a total of 26 extant mammal species from 15 widely dispersed collection sites in northern, central and southern Tasmania (**Mooney, 1993**) .

Owls, owl pellets and accumulation deposits in Tasmanian karst areas and caves:

Three species of owls are known to frequent sandstone rock shelters and solution caves in Tasmania: the Southern Boobook or Mopoke (*Ninox novaeseelandiae*), the Barn Owl (*Tyto alba*) and the Tasmanian Masked Owl (*Tyto novaehollandiae*). The Boobooks use a range of habitats including forests, farmland trees and leafy suburban trees; Barn Owls tend to favour more open habitats, farmland and offshore islands, rather than more densely forested areas and/or open woodlands (which the Masked Owl prefers) where most Tasmanian caves are found (**Hollands, 1991**). Similarly, Boobooks tend to be more insectivorous (insect eaters), in preference to predating on larger mammals such as rats and although known to frequent caves, they do not regularly roost in the same place. Barn Owls are rarely seen in Tasmania and although known to occasionally use caves in mainland Australia, their preferred diet is frogs, lizards, small birds and small rodents such as the introduced House Mouse, rather than the larger range of mammal species which the Masked Owls predate [**pers. comm., D. Hollands, 1998**]. Although the Tasmanian Masked Owl has a varied diet, studies of their pellets indicate that over 90% of their biomass prey food are mammal species (**Mooney, 1993**) and it is suggested that these owls are the likely source for most of the owl pellets found in Tasmanian caves [**pers. comm., N. Mooney,1998**].

The writer has observed the presence of owls and/or their regurgitated pellets, plus a few accumulation mounds in a number of Tasmanian caves in several karst areas: Bubs Hill, Cracroft, Hastings, Ida Bay, Junee-Florentine, Mole Creek, Mount Weld and Precipitous Bluff (see Figure 1). The following list of these karst areas includes those caves which are still active owl pellet accumulation sites (marked by an asterisk "[*]") and sites from where mammal species have been collected or identified (denoted by the hash symbol "[#]"). The records of identified mammal species are listed in Table 1.

- BUBS HILL (western Tasmania): *WCOC Cave* (BH-3) [#]; *The Downpipe Connector* (BH-7) [#];
- CRACROFT (southwest Tasmania): *The Propylaeum* (C-17) and *Cemetery Shaft* [* / #] extension into *Wargata Mina* (C-1), formerly known as *Judds Cavern* - includes large (un-measured) accumulation mound under present day pellets;
- HASTINGS (southern Tasmania): *Newdegate Cave* (H-X7) [# see text below];
- IDA BAY (southern Tasmania): *Hooks Hole* (IB-26) [#] - non-active site with an ancient accumulation mound, approximately 1.0-1.2m wide and 35-40cm high; un-named cave (IB-32) [#];

March Fly Pot (IB-46) [#]; *Pseudocheirus* (IB-97) [?*?/#]; *Machete Pot* (IB-107) [*/#] - active pellet deposition above a small accumulation mound, 0.7-0.8m wide and 15-20cm high;

- JUNEE-FLORENTINE (southern Tasmania): *Owl Pot* (JF-221);
- MOLE CREEK (northern Tasmania): *Honeycomb Cave* (MC-84);
- MOUNT WELD (southwest Tasmania): *Arrakis* - top cave entrance (MW-X1) [#];
- PRECIPITOUS BLUFF (southern Tasmania): *Cueva Blanca* (PB-4); *Bauhaus* (PB-6); *Christmas Cavern* (PB-18) [*].

Small mammal species from owl pellet remains in Tasmanian caves:

The following analysis of mammal species in Table 1, represents the results of a brief examination by the writer of a number of owl pellet sites in Tasmanian caves, during bio-speleological studies over a period of 15 or more years. The list of ten positively identified mammal species (plus a few further possible unidentified species) is not intended to be an exhaustive list or comprehensive statement of all the mammals present at any given cave site and hence should be considered as largely incomplete.

The list merely represents a summary of my records of identification, based on a cursory examination and study of the mammalian remains in the surface scatter of a number of owl pellets, some of which were immediately above accumulation mounds.

All the mammals listed in Table 1 were identified from either skull or mandible (jawbone) remains. The earlier identifications were performed by Bob Green (the former Curator of Vertebrate Zoology at the Queen Victoria Museum in Launceston, Tasmania) and the more recent sub-fossil mammalian remains from Newdegate Cave (H-X7) were identified by the writer - based on a microscopic study of the anatomy and dentition of their mandibles and reference to **Green and Rainbird (1983)** [see Figure 2], plus some reference to **Hall (1975)** and **Triggs (1996)**.

Table 1: Identified mammals from owl pellet remains in Tasmanian caves

Common Name	Scientific name	Cave sites	Identification	Reference
Dusky Antechinus	*Antechinus swainsonii*	C-1 (C-17);	R.H. Green	Clarke, 1987a; 1987b
		H-X7;	A.K. Clarke	
		IB-26; IB-97; IB-107	R.H. Green	Clarke, 1987b;1988
		MW-X1	R.H. Green	Clarke, 1987b
Swamp Antechinus	*Antechinus minimus*	BH-3;BH-7;	R.H. Green	Clarke, 1989
		C-1 (C-17);	R.H. Green	Clarke, 1987a; 1987b
		H-X7	A.K. Clarke	
		IB-26	R.H. Green	Clarke, 1987b;1988
Unidentified dasyurid:	*Antechinus stuartii* (??)	H-X7	A.K. Clarke	
Unidentified dasyurid:	*Sminthopsis leucopus* (??)	H-X7	A.K. Clarke	
Little Pygmy Possum	*Cercatetus lepidus*	H-X7	A.K. Clarke	
Eastern Pygmy Possum	*Cercartetus nanus*	H-X7	A.K. Clarke	
Brown Rat	*Rattus norvegicus*	IB-32; IB-97; IB-107	R.H. Green	Clarke, 1987b;1988
		H-X7	A.K. Clarke	
Swamp Rat	*Rattus lutreolus*	BH-7;	R.H. Green	Clarke, 1989
		C-1 (C-17);	R.H. Green	Clarke, 1987a; 1987b
		H-X7	A.K. Clarke	
		IB-26	R.H. Green	Clarke, 1988

Broad-toothed Rat	*Mastacomys fuscus*	MW-X1;	R.H. Green	Clarke, 1987b
		H-X7	A.K. Clarke	
Long-tailed Mouse	*Pseudomys higginsi*	C-1 (C-17);	R.H. Green	Clarke, 1987a; 1987b
		H-X7	A.K. Clarke	
		IB-26; IB-46; IB-107	R.H. Green	Clarke, 1987b;1988
		MW-X1	R.H. Green	Clarke, 1987b
New Holland Mouse	*Pseudomys novaehollandiae*	BH-7;	R.H. Green	Clarke, 1989
		H-X7;	A.K. Clarke	
		IB-46	R.H. Green	Clarke, 1987b;1988
		MW-X1		Clarke, 1987b
Unidentified Muridae:		H-X7	A.K. Clarke	
Ringtail Possum	*Pseudocheirus pergerinus*	IB-97	R.H. Green	Clarke, 1987b;1988

Small mammal bones from owl pellet remains in Newdegate Cave:

Newdegate Cave (H-X7) is the present tourist cave in the Hastings karst area of southern Tasmania, 125km south of Hobart. In similarity with a number of the other Tasmanian caves where owl pellet remains have been found, Newdegate Cave has an entrance that would have been suitable for the flight of owls, to and fro from the cave. The reasonably sized 2.5-3.0 metre high, 2m wide horizontal entrance (now gated) leads down a short inclined staircase passage through massive speleothems and large calcite coated rock fragments, then flattens out to a gently sloping cave passage leading to the present spiral staircase above the first main large chamber that connects to the *Central Hall*. On the left hand side of the gently sloping passage the cave is floored with flowstone and cave coral, which slopes down to a flattened area with platelets of calcified mud, ancient gours and cave pearl deposits. During the recent rehabilitation efforts in Newdegate Cave, a wide scatter of predominantly fragmented mammalian bone remains were discovered on this short slope of flowstone and cave coral (see subsequent Figure 3).

Prior to the rehabilitation of Newdegate Cave, this slope of flowstone and cave coral, along with the mud platelets, gours with cave pearls, was previously covered by several layers of embedded clay and "blue-metal" gravels that abutted to the central concrete pathway. Consequently, most of the sub-fossil bone material is now coated with a thin layer of clay. Although some of this clay may have been washed down from the entrance or higher up in the cave, most of it appears to have been transported into the cave and inadvertently dumped on the top of the bone deposit and speleothems during earlier stages in the development of pathways into the tourist cave.

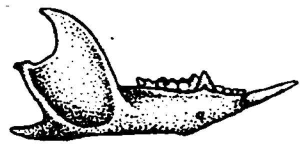
The bone site is appealing as an owl pellet deposit site because it lies beneath some short 3-4m high walls with small ledges that would probably have been suitable for roosting owls. Dominant amongst these sub-fossil skeletal mammalian remains, are the small "harder" or more resilient bones: leg bones, tiny vertebrae, rib-bones, mandibles and teeth, with rare occasional paper-thin fragments of cranial skull. Many of these bone pieces are damaged: broken and fragmented, possibly due to the dumping of clay and gravel overburden (but see concluding comments). In mid-November (1998), approximately 37 major bone pieces were collected along two half-metre transects, each containing five adjoining 10cm square grids with selective preference given to collecting the more easily identified material: 23 mandibles, 7 teeth and 7 leg bones. There were very few matching left and right mandibles of individual species beside each other in any one grid square so total species numbers to date have been determined from the individual mandibles and teeth (six murid incisors and one dasyurid *Antechinus* premolar) and only one of the seven leg bones has been identified.

It is an unknown oddity as to why the bone collection contained 17 left-hand side (LHS) mandibles, compared to only six right-hand side (RHS) mandibles. [Perhaps the reason is due to the fact that my major reference source in Green and Rainbird (1983) only depicted illustrations of RHS mandibles - see Figure 2.]

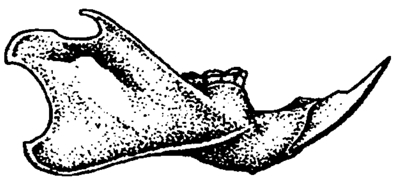
Dusky Antechinus
Antechinus swainsonii x 2
$I\frac{4}{3}, C\frac{1}{1}, P\frac{3}{3}, M\frac{4}{4}, = 46.$

Swamp Antechinus
Antechinus minimus x 2
$I\frac{4}{3}, C\frac{1}{1}, P\frac{3}{3}, M\frac{4}{4}, = 46.$

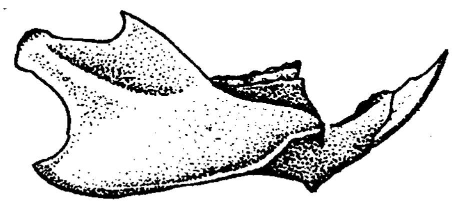
Little Pygmy-possum
Cercartetus lepidus x 2
$I\frac{3}{1}, C\frac{1}{0}, P\frac{3}{4}, M\frac{4}{4}, = 40.$



Eastern Pygmy-possum
Cercartetus nanus x 2
$I\frac{3}{1}, C\frac{1}{0}, P\frac{3}{4}, M\frac{3}{3}, = 36.$

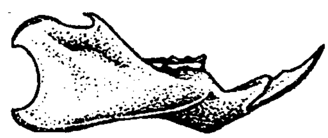


Swamp Rat
Rattus lutreolus x 2
$I\frac{1}{1}, C\frac{0}{0}, P\frac{0}{0}, M\frac{3}{3}, = 16.$



Broad-toothed Rat
Mastacomys fuscus x 2
$I\frac{1}{1}, C\frac{0}{0}, P\frac{0}{0}, M\frac{3}{3}, = 16.$

New Holland Mouse
Pseudomys novaehollandiae x 2
$I\frac{1}{1}, C\frac{0}{0}, P\frac{0}{0}, M\frac{3}{3}, = 16.$



Long-tailed Mouse
Pseudomys higginsi x 2
$I\frac{1}{1}, C\frac{0}{0}, P\frac{0}{0}, M\frac{3}{3}, = 16.$

Figure 2: Diagram depicting the right-hand side (RHS) mandibles of the eight native mammal species found amongst the "presumed" owl pellet remains inside Newdegate Cave (H-X7) in the Hastings karst of southern Tasmania. The diagrams and captions for the depicted mandibles (drawn at twice the normal size of mature adult specimens) are taken from Green and Rainbird (1983). The captions include the respective dental formula for upper jaw (skull) and lower jaw (mandible) dentition: incisors (I), canines (C), pre-molars (P) and molars (M). (These diagrams are reproduced with kind permission from R.H. (Bob) Green and Judy Rainbird.) Note: The introduced Brown Rat species is not shown above.

Apart from the six unidentified leg bones, a preliminary analysis of the identified (ID) skeletal material from the "presumed" owl pellet remains in Newdegate Cave, indicates the presence of 31 individual specimens representing nine confirmed mammal species (see Figure 2) and possibly two other dasyurid species (as listed in Table 1). Details are as follows:

- Dusky Antechinus - 4 specimens: ID from 2 x LHS mandibles; 1 x RHS mandible; 1 x premolar tooth;
- Swamp Antechinus - 1 specimen: ID from 1 x LHS mandible;
- Unidentified dasyurid (antechinus), clustered "wrap around" teeth, with similar appearance to mainland species: Brown Antechinus - 1 x LHS mandible;
- Unidentified dasyurid, possibly White-footed Dunnart - 1 x RHS mandible fragment;
- Little Pygmy Possum - 2 specimens: ID from 1 x LHS mandible; 1 x RHS mandible;
- Eastern Pygmy Possum - 2 specimens: ID from 1 x LHS mandible; 1 x leg bone (humerus) with prominent flange;
- Brown Rat - 3 specimens: ID from 2 x LHS mandibles; 1 x RHS mandible
- Swamp Rat - 6 specimens: ID from 2 x LHS mandibles; 4 x incisor teeth;
- Broad-toothed Rat - 4 specimens: ID from 2 x LHS mandibles; 2 x incisor teeth;
- New Holland Mouse - 3 specimens: ID from 2 x LHS mandible; 1 x RHS mandible;
- Long-tailed Mouse - 4 specimens: ID from 3 x LHS mandibles; 1 x RHS mandible.

Concluding remarks on the small mammal bones and their fragmentation:

Many of the vertical caves in forested areas of Tasmania have been described as mammal traps, where the vertical entrances act as pitfall traps (Clarke, 1988); however these sub-fossil bone deposits are not restricted to caves with vertical entrances. The skeletal remains of small mammal species are often found in caves, particularly near entrances and those caves with narrow fissured or vertical entrances, where animals crawl in for shelter and become trapped or fall into the cave. Apart from owls, there are several mammal predators that use caves and these animals will introduce excreted bone matter into the cave. Based on her study of the older Holocene and Late Pleistocene deposits in Cave Bay Cave, Bowdler (1984) suggests such predators as native cats, Tasmanian Devils, Tasmanian Tiger (Thylacine) and perhaps even the Tasmanian Lion (*Thylocoleo carnifex*) may have used Tasmanian caves as habitation sites. However, many of their prey would have been larger species (compared to those expected from owl roost sites) and unlike the predominantly intact whole bones and skulls regurgitated by owls, the bones left by mammal predators would be chewed and broken.

The position of this small mammal bone site in Newdegate Cave (Figure 3) suggests that it is unlikely that these bones would have simply been washed in to the cave or be the result of animals that have fallen in or been trapped in entrance crevices. Since the bone deposit is located within the entrance passage series to the cave, it is more likely that the skeletal material could have been trampled on by early cave visitors or the labourers engaged in the construction works for establishing the site as a tourist cave.

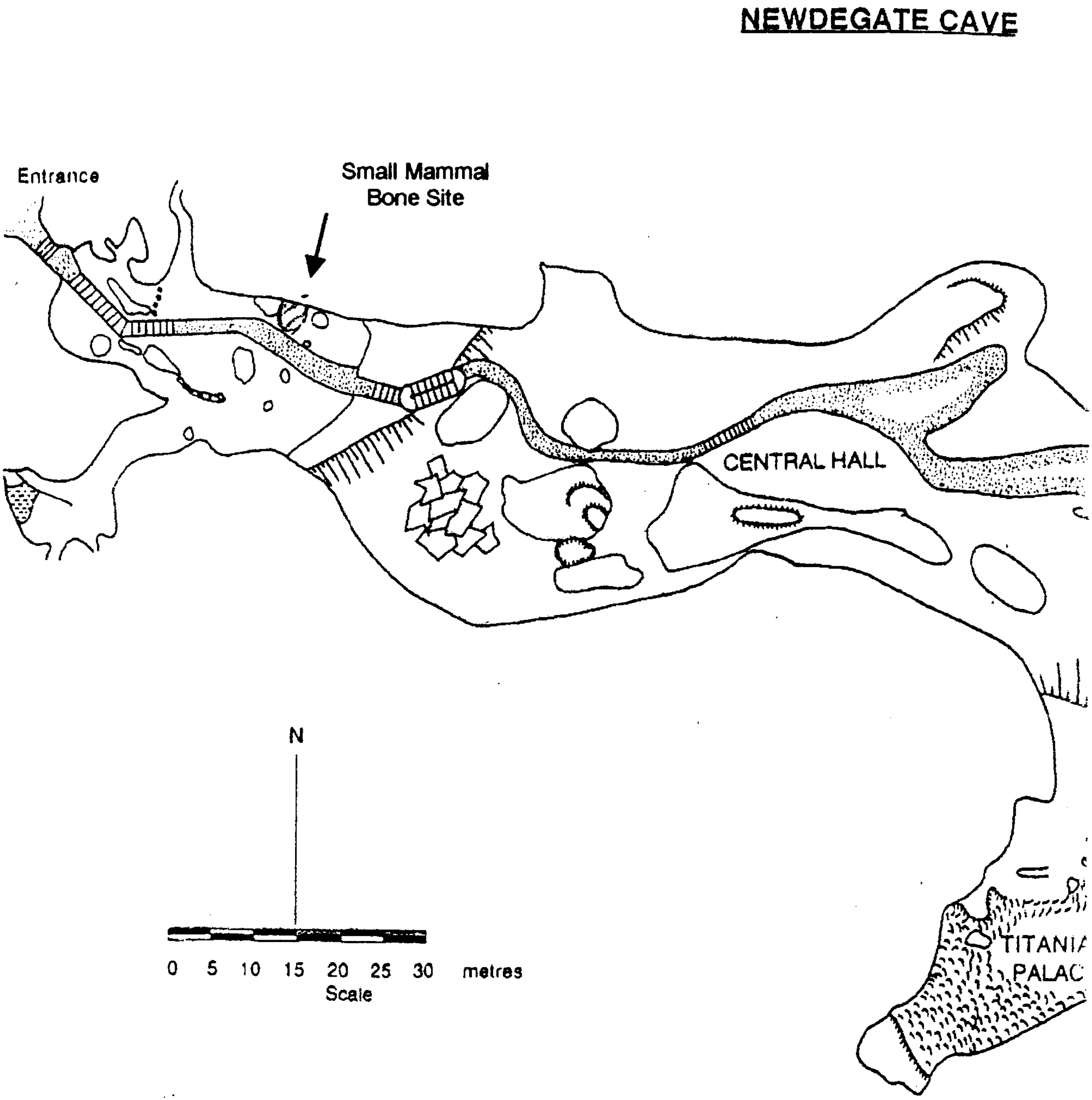


Figure 3: The entrance series of passages and chambers in Newdegate Cave (the present tourist cave in the Hastings karst area of southern Tasmania), showing location of the sub-fossil bone deposit of small mammal species, presumed to be derived from owl pellet remains of the Tasmanian Masked Owl: *Tyto novaehollandiae*. [Map is excerpted from the 1947 cave survey of Newdegate Cave by the former Tasmanian Caverneering Club.]

As previously mentioned, prior to the recent rehabilitation works in Newdegate Cave, this bone site was plastered by layers of compacted clay and blue metal which would have surely caused considerable breakage to the underlying bones. The above-mentioned predator factor could also have contributed to the breakage and fragmentation of bone, since predator species including brushtail possums and reptiles are known to use Tasmanian caves, they might scavenge on owl pellets and also be responsible for the scatter of pellets or small mounds.

However, despite the limited number of specimens collected from Newdegate Cave, the presence of small mammal species and the range of species present with the predominant ratio of rodents over dasyurids, all typify the results found in previous surveys of owl pellet sites conducted by Bowdler (1984) Hall (1975) and Mooney (1993). In most owl pellet deposits, there is a preponderance of rodent bones and although only a small sample was collected during this study, two-thirds of the 31 identified individuals belong to the five murid (rodent) species, which represent over half the total number of nine individual species here. Eight of the nine species (shown in Figure 2) are native species; the additional species: the introduced Brown Rat (*Rattus norvegicus*), may be due to the presence of nearby settlements along the Hastings Road or a legacy of the early pioneering loggers, millers and the tramway construction teams who camped in the foothills near the Hastings Caves Hill.

Assuming my identifications are correct, there are two final observations regarding the small mammal bone deposit in Newdegate Cave: the presence of the New Holland Mouse (*Pseudomys novaehollandiae*) and the Broad-toothed Rat (*Mastacomys fuscus*). The New Holland Mouse is generally only known from coastal lowlands and presently extant species in Tasmania have only been recorded in the far northeast and east coast, down to Freycinet Peninsula [pers. comm., R. Rose, 1998]. The Hastings Caves area abuts on to the Lune River plains which are only a few kilometres from the coast, so it is possible that if these bones in Newdegate Cave represent part of an older deposit, this rodent species may have had a wider distribution in the past. As shown in Table 1 (with reference to Figure 1), my records indicate that the New Holland Mouse has also been recorded in caves of the Mount Weld and Bubs Hill karsts: both of these areas are in excess of 40km from the sea and/or open lowland coastal plains. In his study of the Marble Arch deposit, 40km south of Braidwood (and a considerable distance from the NSW South Coast), Les Hall commented that the New Holland Mouse was only found in the older basal section of his excavated deposit, suggesting that this species had a much wider, more inland distribution in the past. Similarly, the present known distribution range for the Broad-toothed Rat in western Tasmania and alpine regions would suggest that these specimens in Newdegate Cave represent a considerable expansion of its known range. It is possibly further evidence to suggest that these bone remains are part of an older deposit, when species such as the Broad-toothed Rat had a wider distribution. Nick Mooney has also commented that some of the bones collected from his field studies of owl roost sites indicate that the Broad-toothed Rat has previously been found a lot further east and south of its present day habitat [pers. comm., N. Mooney,1998].

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NEWDEGATE CAVE - TASMANIA

References:

Bowdler, S. **(1984)** Hunter Hill, Hunter Island: archaeological investigations of a prehistoric Tasmanian site. *Terra Australis*, **8**: 1-148.

Clarke, A. **(1987a)** Exciting discoveries in the Cracroft Region. *Tas. Cave & Karst Research Group Jnl.*, **2**: 31-38.

Clarke, A. **(1987b)** *A report and commentary on biological studies from caves in southern Tasmania.* Unpublished report: (*Exhibit No. 185*) submitted to the Commonwealth (Helsham) Inquiry into Lemonthyme and Southern Forests. 21pp.

Clarke, A. **(1988)** The biology of caves in southern Tasmania. *Tasmanian Cave & Karst Research Group Jnl.*, **3**: 18-29.

Clarke, A. **(1989)** *Fauna from the caves and karsts of the Bubs Hill area, Western Tasmania.* Unpublished report to Tasmanian Dept. of Parks, Wildlife & Heritage. 24pp.

Green, R.H. and Rainbird, J.L. **(1983)** *Skulls of the Mammals in Tasmania.* Queen Victoria Museum and Art Gallery, Launceston, Tasmania. 99pp.

Hall, L. S. **(1975)** A recent bone deposit at Marble Arch, N.S.W. In Graham, A.W. (1975) [Ed.] *Australian Speleological Federation: Proceedings of the Tenth Biennial Conference, 27-29 December, 1974*: pp. 35-46.

Hollands, D. **(1991)** *Birds of the Night: owls, frogmouths and nightjars of Australia.* Reed Books, Balgowlah, NSW. 224pp.

Mooney, N. **(1993)** Diet of the Masked Owl in Tasmania: past and present. In Olsen, P. (Ed.) (1993) *Australian Raptor Studies: Proceedings of 10th Anniversary Conference, Australasian Raptor Association, Canberra, September 21-22, 1989.* Pp. 160-174.

Triggs, B. **(1996)** *Tracks, scats and other traces: a Field Guide to Australian Mammals.* Oxford University Press, Melbourne. 340pp.

Wakefield, N.A. **(1969)** *An investigation of Late Pleistocene and Recent bone deposits in South-eastern Australia.* MSc Thesis, University of Melbourne.