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Marsupial Fossils from Wellington Caves, New South Wales; the Historic and Scientific Significance of the Collections in the Australian Museum, Sydney

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ABSTRACT. Since 1830, fossil vertebrates, particularly marsupials, have been collected from Wellington Caves, New South Wales. The history of these collections, and particularly of the collection housed in the Australian Museum, Sydney, is reviewed in this paper. A revised faunal list of marsupials from Wellington Caves is included, based on specimens in museum collections. The provenance of these specimens is discussed. The list comprises 58 species, of which 30 are extinct throughout Australia, and a further 12 no longer inhabit the Wellington region. The deposit also contains bones of reptiles, birds, bats, rodents and monotremes.

On the basis of faunal correlation and some consideration of taphonomy in the deposits, the age range of the fossils represented in the museum collections is suggested to be from the late Pliocene to late Pleistocene (with a possible minimum age of 40,000 years BP). Data from new collections indicate that at least three distinct periods of deposition are represented in the cave system.

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KEYWORDS: Australian, marsupials, Pleistocene, Pliocene, cave, fossils, history, Wellington Caves, Faunas, Australian Museum.

The Wellington Caves are about 8 km south of the town of Wellington on the Central Western Slopes of New South Wales (longitude 148° 51' 30E, latitude 32° 31'S) in limestones belonging to the Devonian Garra Formation, at an altitude of approximately 300 m (Fig. 1). They occur in low hills 1 km east of the Bell River, at an elevation of about 50 m above the present stream. They comprise at least five natural caves which have been expanded and much disturbed in historic times by phosphate mining and fossil collection (Fig. 2). Vegetation of the area is tall open forest and the average annual precipitation for the area is about 630 mm, with a slight winter maximum.

These caves were the first known source of marsupial fossils in Australia and have proved to be one of the most prolific. Their significance stems from two main sources. The first is historic; early scientific descriptions of fossil bones constitute an essential background to taxonomic and phylogenetic studies of several groups of Australian marsupials. The second source of significance develops from the large quantity

of fossil bones available, the great diversity of extinct species represented, and the likelihood that they represent at least three periods of deposition (Osborne, 1983).

Historical Background

The history of investigation of Wellington Caves and the fossils found in them, illustrates the philosophical development of the science of vertebrate palaeontology in Australia from its origins at the time of Cuvier, early in the 19th century, to the present day.

The discovery of the caves in the very early days of settlement of the western districts of New South Wales has been documented by Lane & Richards (1963). They give the earliest authenticated reference to the caves as that made by the explorer Hamilton Hume in December 1828. It is probable that they were known to Europeans several years before 1828. Augustus Earle, a colonial artist, who had travelled with Charles Darwin on the *Beagle*, visited the Wellington Valley in

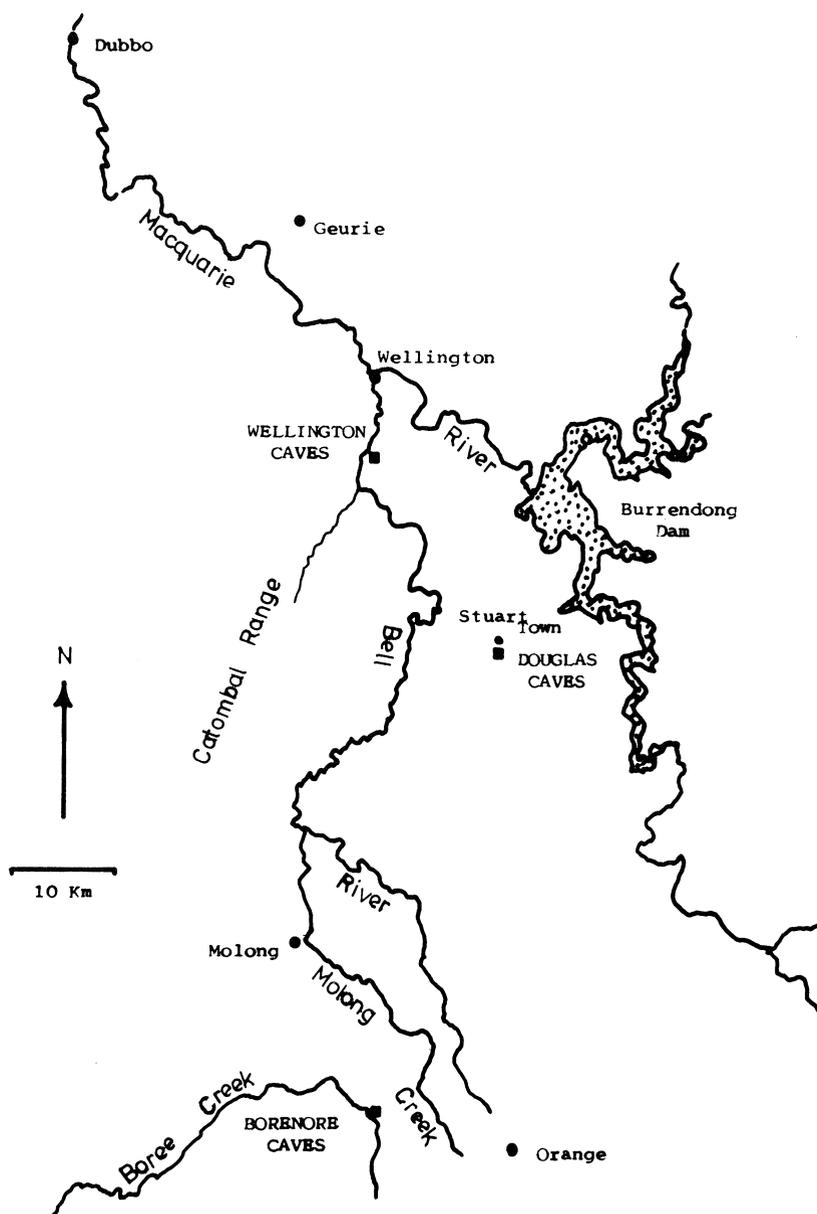


Fig. 1. Map of the Wellington district of New South Wales. Small squares indicate fossil-bearing localities.

1826 or 1827 and sketched a cave then called Mosman's Cave (Hackforth-Jones, 1980), which was most likely the Wellington Cathedral Cave. The existence of the rich deposits of fossil bones in the caves was first reported in a letter from Mr George Ranken, a gentleman of Bathurst, to the Sydney Gazette of 25 May 1830 (Lane & Richards, 1963).

The early 19th century was a period of great interest in natural history and particularly in palaeontology. There was then almost universal acceptance of a "catastrophic" hypothesis as an explanation for the observed discrete stratigraphic distribution of extinct animal forms in the fossil record. The supposition that the Biblical Deluge was the last of such catastrophes

inspired the interest of men of religion, as well as some scientists, both professional and amateur, in extinct animal remains.

In the young colony of New South Wales, two such men were the Surveyor General, Major Thomas Mitchell, a Fellow of the Geological Society of London, and the Reverend John Dunmore Lang, the colony's most prominent theologian. Both were acquainted with Mr Ranken, the discoverer of the Wellington Caves bones (Foster, 1936). Lang was instrumental in taking the first bones collected by Ranken to England for study by Professor Jamieson in Scotland in 1830 (Lane & Richards, 1963; Foster, 1936). Lang's interest was solely ecclesiastical and

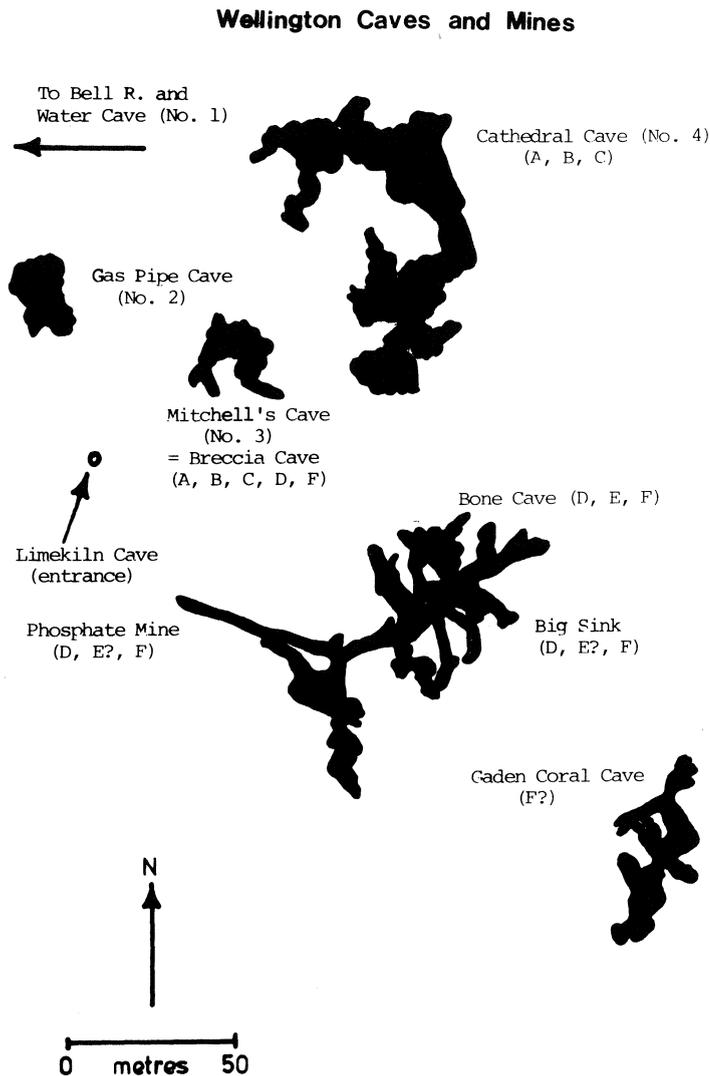


Fig. 2. Map showing the major caves and mines of the Wellington complex. From Frank (1971). Alternative cave names and numbers are shown. Letters A to F indicate the source of fossils in museum collections according to records of collectors as follows: A, Mitchell in 1830; B, Krefft in 1866, 1869; C, H. Barnes, for Ramsay in 1881; D, G. Sibbald for the New South Wales Department of Mines, from 1885 to 1909; E, Dr C. Anderson and colleagues from 1926 to 1932, F, L. Marcus in 1954.

aimed at finding evidence in the colony of the Biblical Deluge. Mitchell's interest was broader. Discoveries in the caves of Europe and England of human fossil bones with bones of extinct animals (Wendt, 1968) had led an English geologist, the Reverend William Buckland, to stress the importance of cave fossils in support of the Deluge hypothesis. Mitchell was well acquainted with the work of both Buckland and Cuvier. In 1829 he visited Bungonia Caves, New South Wales, with the chief aim (which was, however, unsuccessful) of finding "antediluvian remains, like those found by Mr. Buckland" (Foster, 1963: 434). With the same aim, Mitchell and Ranken visited the Wellington Caves and some other small caves in the Wellington Valley in July 1830, to make an initial survey of them and to collect fossil bones (Foster, 1936).

As a result, many more fossil bones were dispatched to England in the early 1830's to be examined by men of science in Scotland, Paris and England. At some time in 1831, Mitchell made a second collection of bones from the caves. These were sent to Paris for examination by Cuvier. Cuvier, however, died in 1832 and these bones were studied by his colleague, Mr William Pentland. Lane & Richards (1963) and Foster (1936) have given an extensive account of the movements of Mitchell's collections. The general ferment of ideas at the time, and the interest generated by the Wellington Caves bones is shown by the fact that Lyell, in his classic "Principles of Geology", published in 1833, referred to the bones collected by Mitchell as evidence supporting non-Cuvierian (i.e. evolutionary) principles (Owen, 1877: viii). Dugan (1980) has pointed out that the marsupial bones

discovered in Wellington Caves by Mitchell in 1830 probably provided the first inspiration for Charles Darwin's "Law of Succession of Types", formulated in 1837.

Sir Richard Owen, at that time Conservator of the Hunterian Museum of the Royal College of Surgeons, London, was the first to name extinct fossil marsupial species from Australia scientifically, on the basis of the bones from Mitchell's collection (Owen in Mitchell, 1838). The study of Australian fossil marsupials became a major part of Owen's life work. He published his last paper on a fossil from Wellington Caves in 1888, at the age of 84! Following receipt of Mitchell's first two collections, Owen received more bones from the Wellington Caves, sent to the Hunterian Museum in 1844 (see Flower, 1844) by the explorer Count Paul Strzelecki. By 1842 Owen's main source of Australian fossils was the Darling Downs of Queensland (Foster, 1936).

By 1866, independent scientific interest in the cave fossils was developing within Australia. Gerard Krefft, who had become Curator and Secretary of the Australian Museum in Sydney in 1861, made a large collection of fossil bones from the Wellington Caves, and sent them to the Paris Universal Exhibition of 1867 (Lane & Richards, 1963). In 1867, Owen requested that the Colonial Secretary of New South Wales grant 200 pounds for further exploration and collection from Wellington Caves (New South Wales Parliamentary Paper, 1882). This was granted and, in 1869, Krefft was directed to undertake the work. It is an indication of the developing maturity of the colony of New South Wales, and the independent attitude of Krefft, that most of the bones collected by Krefft in 1869 were not dispatched to England, but kept in the Australian Museum. Krefft sent Owen reports of his work in 1869 and 1870, accompanied by "duplicate" specimens, casts and photographs of some of the best specimens (*ibid.*, 1882). The specimens that remained in Sydney were, presumably, the first fossils from Wellington Caves to be lodged in the Australian Museum, although the collection was not registered immediately, and was not documented as to the exact origin of specimens.

Krefft's 1870 report to Owen was accompanied by a report from A.M. Thomson, Professor of Geology at Sydney University, describing the limestone of the Caves area and particularly Mitchell's Breccia Cave, from which Krefft's specimens were obtained. Thomson described the excavation of bone from Mitchell's Cave (i.e. Breccia Cave) and suggested that the caves may have originally been carnivore dens or had acted as pitfall traps for large animals (New South Wales Parliamentary Paper, 1882: 11-13). Krefft described several new genera and species (see Mahoney & Ride, 1975), and was particularly fascinated with the dentition of the Marsupial Lion, *Thylacoleo carnifex*. He disagreed publicly with Owen regarding the diet of this animal, considering *Thylacoleo* to have been herbivorous rather than carnivorous (Krefft, 1872a,b).

Two prolonged debates regarding the ancestry of man in Australia also stemmed from Krefft's discoveries in Wellington Caves. The discovery of the "Krefft tooth", a supposed human molar fragment, in the same breccia as the bones of extinct marsupial species, was claimed to be the first evidence for the antiquity of Aboriginal man in Australia, and for his coexistence with the "megafauna". However, no further evidence of man was ever found in the breccia. It was established by Campbell (1949) that the tooth was, in fact, not human, but a fragment of a macropodid premolar. Teeth of the Dingo, a placental species introduced by Aboriginal man to the Australian fauna, were also supposedly discovered by Krefft in the Wellington Caves fossil breccia. For nearly 100 years the contemporaneity of these teeth and the extinct species in the breccia was doubted. Gill & Sinnott (1973) demonstrated by a fluorine test that these Dingo teeth were, in fact, younger than bones of extinct species from Wellington Caves.

In 1874, Krefft was succeeded at the Australian Museum by Dr E.P. Ramsay, under whose leadership even more extensive collections were made from Wellington Caves. At the instigation of Sir Richard Owen and Sir George Macleay, the Agent General to the Colonial Secretary, funds were allocated to the Australian Museum in October 1876 for the further exploration of the caves of the western and southern districts of New South Wales, and to explore Australian rivers to collect endemic fish (New South Wales Parliamentary Paper, 1882). In June 1881, Ramsay dispatched Henry Barnes to collect fossils from Wellington Caves. Barnes, who had worked with Krefft at the caves in 1869, continued this work for five months. Ramsay wrote two extensive reports (*ibid.*, 1882) to the Trustees of the Museum on the progress of work at Wellington Caves. He was the first to identify the caves by number (see Fig. 2) and gave comparatively detailed information about the discovery of some of the fossil specimens. The many fossil bones excavated by Barnes and Krefft were stored in the Australian Museum, and comprise part of what is now referred to in the Museum fossil registers as the "Old Collection".

In 1884, the caves came under the control of the New South Wales Department of Mines, who engaged George Sibbald as the first keeper of the caves in 1885. Sibbald continued to work at the caves and collect fossils for 25 years until 1909 (Lane & Richards, 1963). Most of the fossils collected during this period were stored, unregistered, in the collections of the Geological and Mining Museum, Sydney.

By 1909, professional scientific interest in collection of fossils from the Wellington Caves virtually ceased. Between 1913 and 1917 the New South Wales Phosphate Company mined the breccia-filled passages in the vicinity of the existing caves in search of phosphate for fertilizer. It is thought that the bone of the breccia which clogged these passages was the predominant source of phosphate (Frank, 1972: 80).

However, the phosphate source was probably not only bone, but phosphatic rim-rock (Osborne, 1983). Although many valuable specimens must have been exposed during the mining operations most, presumably, were crushed during extraction of the fertilizer.

The vast number of bones which comprised the Old Collections of the 19th and early 20th Century largely remained unsorted and unstudied until 1926, when Charles Anderson, another Director of the Australian Museum (1921–1940) revived interest in the Wellington Caves fossils (see Anderson, 1926, 1929). Some fossil specimens were sent to the Australian Museum early in 1926 by a Shire Clerk of Wellington, J. Harvey Truman, who had obtained them while electric lights were being installed in Cathedral Cave (Lane & Richards, 1963). Anderson and G. Clutton, of the Australian Museum staff, also collected fossils in 1926, mainly from the passages of the phosphate mines (Anderson, 1926). In 1932, Anderson, accompanied by Mr W. Schevill of the Harvard University Museum of Comparative Zoology, again visited the caves and made an extensive collection from the phosphate mine passages (Anderson, 1932)

Anderson's interest resulted in the registration and identification of many of the specimens in the Old Collection. He was also responsible for the transfer of many previously unregistered specimens from the Geological and Mining Museum in Sydney to the Australian Museum in 1930, 1934 and 1935 (see the MF register of the Australian Museum). In 1939, German scientists made a large collection from the Bone Cave, Mitchell's Cave and the Phosphate Mines (Schroeder & Dehm, 1940; Dehm & Schroeder, 1941). These authors report collecting a large range of species, both large and small. This collection was eventually shipped to Munich, where it presumably remains in the Institute for Palaeontology and Historical Zoology. The collection has not been described. The best documented recent collection from the caves was made by L.F. Marcus in 1954, and is deposited in the University of California Museum of Paleontology (UCMP Accession number 1601).

Current Scientific Significance

The large collections from Wellington Caves, which have accumulated over 150 years, represent an important source of information about many extinct marsupial species. One hundred Australian fossil marsupial species names were proposed between 1838 and 1900 (Mahoney & Ride, 1975). Of these 23 are attributed either definitely, or probably, to Wellington Caves as the type-locality. Until the present study, most of these taxa were in need of revision. A further 54 fossil species were named from the other "classic" locality, the Darling Downs region of Queensland. These deposits were both assumed by 19th century workers to be of Pleistocene age. As recently as 1933, Charles Anderson wrote that "information regarding Tertiary marsupials is almost a blank" (Anderson,

1933: xxi). At that time only one Tertiary species, *Wynyardia bassiana*, was known.

This lack of an older record probably contributed to the waning of general interest in marsupial palaeontology in the first 50 years of this century. Intensive effort to discover Tertiary marsupials in Australia was pioneered by R.A. Stirton in the early 1950's. Initial modest success (e.g. Stirton, 1955, 1957) rapidly rekindled interest, and led to a progressively more intensive phase of exploration. This resulted in discovery of Tertiary representatives of most Australian marsupial families (excluding only the Tarsipidae, Myrmecobidae and Notoryctidae) extending back, in most cases, as far as the early Miocene (15 million years BP) (Archer & Bartholomai, 1978).

In 1964, W.D.L. Ride stressed the need for "rediscovery" and reinterpretation of the classic fossil localities and faunas. In fact, such work was then already underway in Queensland, where Woods (1960) had established the presence of two distinct stratigraphic units and two faunas within the Darling Downs region. He designated the eastern Darling Downs fluvial deposits as Pleistocene in age and presumed the older unit, the Chinchilla Sand, to be late Pliocene or early Pleistocene age. Revision of fossil taxa from these Queensland fossil faunas has been the subject of many papers by Bartholomai over the past 20 years (e.g. Bartholomai, 1963, 1970, 1973, 1975, 1976). The Chinchilla Sand is now considered to be early to middle Pliocene in age (Rich *et al.*, 1982).

The Wellington Caves also rank as one of the classic localities in Australia for marsupial fossils, and hence deserve similar revisionary study and renewed investigation. Recent geological studies have shown that the deposit is undoubtedly not stratigraphically homogeneous (Frank, 1971, 1972, 1975; Francis, 1973; Osborne, 1983). These studies have suggested the probability that the bone-bearing breccia represents at least three periods of deposition, probably ranging from the Pliocene to the late Pleistocene (Osborne, 1983). This geological hypothesis has formed the basis for a new stratigraphically controlled analysis of the fossils, currently being undertaken through the School of Zoology, University of New South Wales.

Results of that study are not yet available. However, a preliminary study involving revision of the existing museum collections has been undertaken (Dawson, 1982a). The background to, and some results of, that study are reported here.

Revision of Museum Collections from Wellington Caves

The large number of specimens from Wellington Caves in the Australian Museum and other institutions has provided an opportunity to investigate the validity of several fossil taxa, and to study variation in extinct species described from this location and elsewhere in Australia. Another aim of the revision of museum

collections was to establish the range of species present in the deposit. It was hoped that this preliminary study would enable use of faunal correlation to test the geological hypothesis as to the age range of the deposits.

The value of faunal correlation in estimating the relative age of Australian fossil deposits has recently been stressed by Archer (1978) and Rich *et al.* (1982). A preliminary requirement is an understanding of the range of variability within species, and consequent understanding of the morphological boundaries of each species.

For historic and biogeographic reasons, studies of fossils from the Queensland Darling Downs are of particular importance for stratigraphic correlation and palaeoecological interpretation of the Wellington Cave fossils. Other studies of particular relevance, because of the geographic relationship of the deposits to Wellington Caves, are of the Pleistocene faunas of Lake Menindee (Tedford, 1967), Bingara (Marcus, 1976), Lake Victoria region (Marshall, 1973), and Lake Tandou (Merrilees, 1973) in New South Wales; and of Texas Caves (Archer, 1978), and Gore (Bartholomai, 1977) in Queensland. Similar faunal studies relevant to the development of an Australia-wide picture of Pleistocene marsupials are those of Marshall (1974) on the Keilor "cranium site", and Gillespie *et al.* (1978) on Lancefield Swamp in Victoria; Hope *et al.* (1977) on Seton Rock Shelter, Kangaroo Island, Williams (in Wells, 1978) on Dempsey's Lake, and Smith (1971, 1972) and Wells and colleagues (as yet largely unpublished) on the fauna of Victoria Cave, Naracoorte, South Australia; Murray & Goede (1977) on Tasmanian caves; and Baynes *et al.* (1975) and Balme *et al.* (1977) on Devils Lair, and Merrilees (1968) on Mammoth Cave, Western Australia.

Certain eastern Australian deposits containing rich marsupial faunas are known, by potassium-argon dating and by the level of phylogenetic development of taxa in them, to be of Pliocene age (see Rich *et al.*, 1982, for a summary of the age of Tertiary marsupial faunas). Those of most relevance for comparison with the Wellington Caves assemblage are the Chinchilla Sand local fauna of southeastern Queensland (approximately 4 million years BP based on stage of evolution), the Bow local fauna, New South Wales (approximately 4 millions years BP based on stage of evolution), the Hamilton local fauna, Victoria (4.3 million years BP, radiometric dating) and the Bluff Downs local fauna, Queensland (4.5 million years BP based on radiometric dating).

Problems of Provenance

There are fossil specimens from Wellington Caves in museums and private collections throughout Australia and much of the world. The largest collectons are in the Australian Museum, Sydney, the

British Museum (Natural History), London, and the University of California Museum of Paleontology, Berkeley. The present study has involved all three of these collections, with most emphasis on the Australian Museum collection. In many cases the documentation of the museum specimens is poor. The problem of provenance of these museum specimens exists on three levels: (1) confirmation of the origin of a specimen from any one of the Wellington Caves (see Fig. 2), (2) identification of the particular cave or fissure of origin of a specimen and (3) identification of the geological strata from which a specimen originated.

Although Frank (1971) and Osborne (1983) have identified at least three stratigraphically distinct bone-bearing units in the clastic fill of the Wellington Caves, no specimen in existing museum collections is labelled as to the stratigraphic unit of its origin. Frank (1971, 1975) found that the highest bone density was in the ubiquitous units which he designated 3R and 3RB, and that these contained bones of the largest animals. It is likely, therefore, that the majority of bones in existing collections have come from these units.

Some museum specimens are accompanied by relatively detailed information as to their origin. In the collections of L.F. Marcus in the University of California Museum of Paleontology, Berkeley, each specimen is accompanied by a locality number indicating the particular cave of origin. In the Australian Museum collections 47 specimens (AM F31012-F31057), collected by C. Anderson and W. Schevill in February 1932, originate from "... the drives put in some years ago by a Phosphate Company in search of fertilizer..." (Anderson, 1932). Similarly, 25 specimens (AM F18896-F18920), collected by C. Anderson and G.C. Clutton in 1926, probably all originated from "... the passages driven into the hill by the Phosphate Company..." (Anderson, 1926: 369). A further eleven specimens (AM F18658-F18870) were collected in one of the caves (probably Cathedral Cave) by a Shire Clerk of Wellington, J. Harvey Truman, early in 1926 (Anderson, 1926: 368). In all, 57% of the total number of marsupial species identified here from Wellington Caves are represented in these relatively well documented collections.

The provenance, at Wellington Caves, of specimens collected prior to 1926 is more difficult to authenticate, although it can be established that they are derived from four major collection episodes. These are (1) the first collections by Mitchell in 1830, 1831; (2) the collections of Kreffft in 1866, and Kreffft and Thomson in 1869; (3) collections made by H. Barnes under the direction of Ramsay in 1881; and (4) collections made between 1885 and 1917, while the caves were under the control of the New South Wales Department of Mines. Those made prior to 1884 were probably all from Cathedral Cave and Mitchell's (Breccia) Cave.

Specimens which were sent to the British Museum are listed by Lydekker (1887). Most originate from the

collections of Krefft (who mentions, in his 1870 report, the dispatch of 1000 specimens!) and Barnes (under Ramsay). Their detailed reports (New South Wales Parliamentary Paper, 1882: 4, 8, 44, 45) confirm the origin of the specimens from Cathedral Cave or Mitchell's Cave.

The British Museum collections also include those specimens collected by Sir Thomas Mitchell in 1830 and 1831. Problems relating to the exact provenance of these specimens have been discussed by Mahoney & Ride (1975: 33, 34). These authors have concluded that it is not possible to exclude an unnamed site "...on the north bank of the Macquarie, 8 miles east of Wellington Caves", nor the caves at Buree (= Tunnel Cave, Borenore) as the possible source of some of Mitchell's specimens. However, Frank (1972), in a study of the Borenore Caves, has noted that very little bone or organic material is present in this deposit. From Mitchell's (1838) description, it is clear that Wellington Caves, and particularly the Breccia Cave, were the source of most of the specimens that were sent to England.

The majority of the specimens in the Australian Museum, labelled as coming from Wellington Caves, bear the designation "Old Collection". These were collected prior to August 1887, when the current system of registration (F registers) commenced. They were registered, sporadically, from 1897 onwards. A few bear corroborative information as to their provenance, e.g. F4643, "*Diprotodon* ulna, Wellington Caves, Cave 3, Collected H. Barnes".

Transfer of specimens from the Geological and Mining Museum, Sydney, to the Australian Museum took place in October 1930, then in 1934, 1935 and 1939, to be registered in the Australian Museum under the prefix MF. Many more specimens were transferred in 1963, 1964, 1968 and 1976 (see Australian Museum F register). There are no records available as to the detailed provenance of most of these specimens, other than the designation "Wellington Caves". However, it is probable that they were collected between 1884 and 1917, the period during which the Caves were under the control of the New South Wales Department of Mines. Some bear corroborative information regarding their origin from the Wellington Caves, e.g. MF 465 (old no. 1389), "macropod lower incisor, Collected J. Sibbald, Cave No. 3, Wellington".

It is possible that some of the specimens from the Mining Museum were mislabelled prior to their transfer to the Australian Museum. For those specimens without any other documentation as to their origin, the state of preservation provides the best supporting evidence for origin from one of the Wellington Caves. Of the taxa listed in Table 1, five species are only represented by single specimens from the old Mining Museum collections. These are *Phascolonus gigas* (MF728/9), *Thylogale* sp. (MF304), *Macropus* sp. cf. *M. giganteus* (MF124), *Macropus* sp. cf. *M. dryas* (F47077e) and *Macropus* sp. cf. *M. rama* (F47115). All other taxa included among the specimens

transferred from the Mining Museum are also represented in various other better documented collections from Wellington Caves.

Examples have been found indicating that some mislabelling of museum specimens has probably occurred, e.g. (1) AM F1063, "*Macropus* maxillary fragment", a specimen similar in preservation to those known to come from Wellington Caves, is labelled "Cave Flat, Murrumbidgee, collected Jenkins", but bears the letters "W.C." in black ink on the specimen; (2) AM F30330, the holotype of *Halmaturus thompsonii* Krefft, 1870 was registered in 1931. Mahoney & Ride (1975) give Wellington Caves as the probably type-locality for this species. However, the preservation of the holotype is unlike any other known to come from Wellington Caves, and is, in fact, typical of specimens from the Darling Downs, Queensland. It is thus considered here to have been wrongly labelled at the time of registration.

Specimens known to originate from Wellington Caves vary in colour, degree of mineralisation, and in the hardness and colour of any adhering matrix. The observed variety of preservation states is typical of fossils from cave earth and cave breccia from several localities. Thus, specimens indistinguishable in preservation from Wellington Caves specimens are known from Molong (e.g. AM F31734) and from Guerie, 16 km north of Wellington (e.g. AM F41457, collected by Robertson and Fletcher, 1944). Preservation alone, therefore, is not an infallible guide to a specimen's origin from Wellington Caves.

Unfortunately a degree of uncertainty will always remain as to the exact provenance of many specimens from the "Old Collections" in the Australian Museum. It is clear, however, from the history of the caves and the documentation available, that only a small proportion of the total collection is likely to be mislabelled as to locality. This study has proceeded on that assumption.

Marsupials from Wellington Caves

The marsupial taxa represented in Museum collections from Wellington Caves are listed, with annotations, in Table 1. This faunal list has been compiled after study of specimens in the collections of the Australian Museum, Sydney, the British Museum (Natural History), London, and the Museum of Paleontology, University of California, Berkeley. At least one representative specimen from a museum collection is nominated for each species. Where possible, these examples have been chosen because they are accompanied by documentation supporting their origin from the Wellington Caves. For most species, corroborative evidence of occurrence in one of the Wellington Caves has been obtained from new collections made by the author and colleagues from the University of New South Wales in 1983 and 1984, as noted in Table 1.

In many cases the origin of a specimen from a

specific cave in the system is documented. In other cases only the name(s) of the collector(s) is known. This is taken as corroboration of origin from Wellington Caves where it is established that this was the only location worked by that person (e.g. Anderson & Schevill in 1932).

In most cases a detailed comparative morphometric study has been undertaken for each species. Some results of these studies have been published; on thylacines (Dawson, 1982c), on Tasmanian Devils, *Sarcophilus* spp. (Dawson, 1982b), on the Marsupial Lion, *Thylacoleo carnifex* (Archer & Dawson, 1982) and on wombats (Dawson, 1981, 1983a,b). Detailed studies of the macropodids have also been undertaken but are yet to be published (see Dawson, 1982a).

Two of the mammalian species which Mahoney & Ride (1975) attribute to Wellington Caves are considered here to be *nomina dubia*. These are *Osphranter gouldii* Owen, 1874, and *Hypsiprymnus spelaeus* Waterhouse, 1845. In each case the holotype was destroyed when the Royal College of Surgeons, London, was bombed in 1941 (see Mahoney & Ride, 1975). A neotype cannot be assigned to either of these names since no specimens other than the holotype have been referred to either species, and the original descriptions are inadequate to assign any specimen to either of these taxa.

Non-marsupial Vertebrates from Wellington Caves

Reptiles. Numerous small reptilian jaw fragments are represented in the Australian Museum collections, both old and new, from Wellington Caves. Few have been registered, and they remain entirely unstudied. Most represent agamids and varanids. The giant varanid, *Megalania prisca*, is also present in the fauna, being represented by several postcranial fragments, including a dorsal vertebra, AM F16494. A portion of a carapace, AM F18662, represents a turtle or tortoise in the fauna. It is probably the specimen mentioned by Thompson (New South Wales Parliamentary Papers, 1882), found in Mitchell's Cave.

Birds. Rich (1975) notes the following fossil birds from the Wellington Caves: *Dromaius patricus* (? *D. novaehollandiae*, Casuariidae, emu); Dromornithidae (mihirung bird); *Progura gallinacea* (Megapodiidae, mound builder); *Casuarius lydekkeri* (Casuariidae, cassowary). Lydekker (1891a) first claimed the existence of a fossil cassowary from the Pleistocene of New South Wales, after examination of a cast in the British Museum. Rothschild (1911) based his description of *C. lydekkeri* on this cast (BM A158 or B10394), claiming that it was from the Queensland Pleistocene. Miller (1962) confirmed that this cast is from a distal end of a tibiotarsus, MF 1268, a specimen in the Australian Museum. This specimen was transferred to the Australian Museum from the Mining Museum, Sydney, in a tray of specimens of mixed origin (Miller, 1962). Miller (1962), following

H.O. Fletcher, concluded that this specimen came from Wellington Caves. After examination of the specimen, I have concluded that this is very unlikely, on the basis of its preservation. The greenish colour of the bone is quite unlike any specimen known to come from Wellington Caves, but not unlike specimens from the eastern Darling Downs. It is concluded here that this species should not be included in the Wellington Caves fauna.

In May 1984, Tim Flannery of the School of Zoology, University of New South Wales, collected a tibio-tarsus in the Bone Cave which is probably from a species of *Genyornis* (P. Rich, pers. comm., 1984).

Monotremes. Murray (1978) has confirmed the identity of a fossil echidna, *Zaglossus ramsayi* Owen, 1844, the holotype of which (AM F10948) was obtained by E.P. Ramsay from the Breccia Cave (No. 3), Wellington Caves. This species has also been reported from Pleistocene deposits of Henschke's Cave, South Australia; King Island and Montagu Caves, Tasmania; and from Mammoth Cave, Western Australia (Murray, 1978; Pledge, 1980).

Rodents. Rodent jaws are abundant in new collections from Wellington Caves but these have not as yet been described. They are particularly abundant in the Bone Cave. A new genus and species, *Paraleporillus stirtoni* Martinez & Lidicker, 1971, has been described on the basis of a specimen from the Bone Cave. The holotype was collected by L.F. Marcus in 1954. This species is considered by Watts & Aslin (1981) to be a junior synonym of *Pseudomys australis*.

Bats. *Macroderma gigas*, the Ghost Bat, has been reported from an unknown locality in Wellington Caves by Molnar *et al.* (1984). Additionally, skulls and jaws of a new, more primitive species of Ghost Bat, possibly ancestral to *Macroderma gigas* (S. Hand, pers. comm. 1984) have been isolated from breccia from the Big Sink, collected by Michael Archer and students in 1982.

Discussion

The faunal assemblage from Wellington Caves contains a very high proportion (65%) of extinct or gigantic marsupial species, most of which are also typically found in other Pleistocene-aged faunas of eastern Australia (e.g. the eastern Darling Downs, Queensland, and Bingara, New South Wales). However, geological evidence suggests that a component of the Wellington deposits could predate the Pleistocene (Osborne, 1983).

Although, faunally, the Pliocene/Pleistocene boundary itself is not yet defined, a clear faunal difference can be seen between the better documented earlier Pliocene faunas, and those of middle or late Pleistocene age. Thus, among the diprotodontids, the presence of *Diprotodon optatum* and *Zygomaturus trilobus* only, supports a maximum age within the

Pleistocene, since neither of these species is known from a Pliocene deposit (Archer & Bartholomai, 1978; Archer, 1977). The most common palorchestid in Wellington Caves is *Palorchestes azael*, known only from Pleistocene deposits. The smaller species, *P. parvus*, once thought to occur only in the Pliocene (Woods, 1960), is now known to occur in the Pleistocene as well (Tedford, 1966; Bartholomai, 1977). Therefore, the occurrence of a species similar to *P. parvus* from Wellington Caves cannot be used to imply a greater stratigraphic range within the deposits.

Recent work has established the value of species of *Thylacoleo* in faunal correlation (Archer & Dawson, 1982). Thus, the Bluff Downs, Chinchilla Sand and Bow local faunas contain a large thylacoleonid (*Thylacoleo crassidentatus*) with dental features that are morphologically primitive compared to *T. carnifex*, the species typically found in Pleistocene deposits. The evidence available is most parsimoniously interpreted to indicate that evolution of the *T. crassidentatus*-*T. carnifex* lineage was orthogenetic. Progress along this morphocline is even suggested within the Pliocene by apparently different aged faunas, with *T. crassidentatus* from the older Bluff Downs fauna being structurally ancestral to *T. crassidentatus* from the younger Chinchilla Sand fauna (Archer & Dawson, 1982). Analysis of the larger number of specimens of *Thylacoleo* sp., in the museum collections from Wellington Caves, has shown that only one species, *T. carnifex*, is represented (Archer & Dawson, 1982). Specimens included in this analysis come from Bone Cave, Mitchell's Cave and Cathedral Cave. The results suggest that the period of deposition of these three units, although of unknown duration, was not long enough for significant evolutionary change to occur in this genus. Also, relatively large samples of *Thylacinus cynocephalus* and *Sarcophilus lanarius* from the same caves are not unduly variable (Dawson, 1982b,c) as could be expected if the samples represented a very long period of accumulation. It is concluded that the Museum collections do not contain a component local fauna of early or mid-Pliocene age, and probably represent deposits laid down from the early Pleistocene onwards.

Studies currently underway in the School of Zoology, University of New South Wales, now indicate that bones recently collected by the author and colleagues from the Big Sink from the upper member of the Phosphate Mine Beds (following the stratigraphy of Osborne, 1983) are of late Pliocene age. The unit is characterised by many specimens of a species of *Protomnodon*, tentatively assigned to *P. devisi*, a taxon previously known only from the Pliocene aged Chinchilla Sands of Queensland (Bartholomai, 1973), and by many specimens of a new, plesiomorphic species of Ghost Bat, genus *Macroderma*. This fauna will be described in a future paper. It is clearly derived from a stratigraphic unit of

the Wellington Caves system which is not represented in the old museum collections.

Faunal considerations can also be taken into account in estimating the minimum age of the cave deposits, as represented by specimens in museum collections. The most recent review of evidence pertaining to the timing of extinction and dwarfing events of the late Pleistocene is that of Hope (1982). This suggests (a) that this was not synchronous throughout eastern Australia; (b) that the major episode occurred at or before 30,000 BP in inland areas, but that some giant taxa survived until approximately 20,000 BP in peripheral and particularly southern areas of the eastern continent; there is some evidence to suggest a few giant species survived until about 16,000 BP in Tasmania (Goede *et al.*, 1978) and on Kangaroo Island (Hope *et al.*, 1977); (c) that most extinctions and incidences of dwarfing occurred during a period which was wetter than the present, and predated the period of maximum aridity associated with the last glacial maximum, which occurred at approximately 18,000 BP (Bowler, 1980; Singh *et al.*, 1979). According to these hypotheses, and considering the geographic position of Wellington Caves, it would be expected that the major extinction event in that area occurred at least prior to 25,000 BP.

A particularly interesting aspect of the faunal assemblage from Wellington Caves is the almost complete absence of modern species of *Macropus*, even of the species of *Macropus* wallabies which are known from several faunas of late Pleistocene age elsewhere in Australia. At least ten species of *Macropus* are represented in the collections from the caves (see Table 1). All differ in some degree from modern species, although three modern species are represented by giant forms, here designated as subspecies. These are *Macropus giganteus titan*, *Macropus robustus altus* and *Macropus agilis siva*, all found in other sites of Pleistocene age throughout eastern Australia (Bartholomai, 1975). This almost complete absence of modern forms is similar to the situation found in the faunas of the eastern Darling Downs and Bingara, but contrasts with faunas of such localities as Naracoorte Caves, Cement Mills, Texas Caves, Lake Menindee, Lancefield Swamp and the Western Australian faunas of Devil's Lair and Mammoth Cave, all at least older than 20,000 BP (Hope, 1982). Each of these faunas contains at least one modern species; e.g. *M. rufogriseus* (Naracoorte, Lancefield, Lake Colongulac), *M. parryi* (Cement Mills), *M. dorsalis* (Cement Mills, Lancefield, Texas Caves), *M. rufus* (Lake Menindee, Dempsey's Lake), *M. eugenii* (Naracoorte Caves) and *M. greyi* (Naracoorte Caves). In Western Australia the fauna of Mammoth Cave, thought to have a minimum age of 37,000 BP (Archer *et al.*, 1980) contains *M. eugenii*, *M. irma* and *M. fuliginosus*. These same species occur throughout the well dated sequence from Devil's Lair to the lowest levels dated by carbon 14 at 31,000 BP

(Balme *et al.*, 1978). This apparent absence, in the Wellington Caves, of the most recently evolved group of modern species, therefore implies a minimum age definitely greater than 20,000 years BP, and probably greater than 37,000 years BP for the Wellington Caves bones.

Along with this faunal evidence, observations on the taphonomy of the bones must be taken into account in assessing the probable minimum age of the bone bearing deposits. The horizontal bedding and general taphonomy of bones in Unit 3RB (Frank, 1972; Osborne, 1983) suggests that its minimum age (i.e. the time of its secondary deposition in that strata) coincides with a period when hydrological conditions were much wetter than now. There was evidently a much higher water table than now, or much ponding of water in the caves at the time of deposition of unit 3RB. However, that component of Frank's unit 3R, which is stratigraphically above unit 3RB, was deposited under much dryer conditions, at least as dry as the present (Frank, 1972). Collections made in 1983 by members of the School of Zoology, University of New South Wales, have established that this unit (3R) also contains predominantly large extinct species, at least where it occurs in the Bone Cave.

The work of Singh *et al.* (1979) and Bowler (1980) on the sediments of Lake George in the southern tablelands of New South Wales, and on the Mallee landforms of southwestern New South Wales, respectively, supports a hypothesis of prolonged periods of high water tables and full lakes in the late Pleistocene, punctuated by at least three arid periods, during which conditions were as dry as the present or dryer. These authors independently present evidence from different sources to suggest that lakes were full from at least 64,000 BP until approximately 22,000 BP, after which time conditions rapidly dried, reaching a period of maximum aridity much drier than at present at about 18,000 BP. As suggested above, the faunal evidence suggests a minimum age much greater than this last arid period. In fact, the combined faunas and stratigraphic evidence suggests that the arid period represented by unit 3R was not that of the most recent glacial maximum. According to Singh *et al.* (1979) and Bowler (1980), the last period of extensive aridity prior to that of 18,000 BP occurred at approximately 128,000 BP. Thus, although the evidence is far from conclusive, combined faunal, stratigraphic and hydrological information has suggested the tentative proposal here that the minimum age of the marsupial bones in the Wellington Caves (at least for bones from Bone Cave, Mitchell's Cave and the lower levels of the Cathedral Cave floor) could be near the end of the penultimate glacial, i.e. approximately 128,000 BP (Singh *et al.*, 1979; Bowler, 1980).

Conclusions

The systematic study of the museum collections from Wellington Caves involved revision of many

fossil taxa described last century (Dawson, 1981, 1982a, 1982b, 1982c, 1983a, 1983b). Of the twenty-three fossil marsupial species listed by Mahoney & Ride (1975), for which Wellington Caves is the type-locality, or probably type-locality, only seven have been retained as full species. Nine have been synonymised with species described previously from other localities. One has been retained as a subspecies of a modern form. Two have been declared *nomina dubia* (Dawson, 1982a). The four diprotodontid species which are represented were not revised in this study. Additionally, at least three new genera, one a dasyurid and two macropodines, are represented in the collections. At least four new species of *Macropus* are represented (Table 1). These new taxa will be described in forthcoming papers by this author.

Wellington Caves fossils will continue to be of importance in comparative studies of faunas throughout eastern Australia because of the range of species represented. The large number of bones which remain unexcavated from the caves constitute a source of larger samples of those species which are, as yet, known from fragments only. Current excavations have revealed the caves to be an extremely rich source of many small species of marsupials and rodents. Some of these represent taxa which are, as yet, unrevised or undescribed.

One of the chief aims of current work at the caves is to obtain faunal data to corroborate the geological hypothesis of Osborne (1983), which suggests that at least three major periods of breccia deposition are represented in the Wellington Caves system. Early results of this new study, and the data presented in this paper, suggest that a fauna of mid to late Pliocene age is represented in the Big Sink. It is probable that the bone-rich deposits of Bone Cave and Mitchell's Cave, which were the source of most specimens in the old museum collections, accumulated during the Pleistocene (probably over a prolonged period), but that deposition in those caves probably ceased before the late Pleistocene. An important thrust of future work will be to obtain a more accurate estimate of the age of the bone in various stratigraphic horizons in the caves.

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Table 1. Marsupialia from Wellington Caves.

- * Numbers prefixed by F- or MF- are Australian Museum specimens. Those prefixed by UCMP are from the University of California Museum of Paleontology; BM indicates specimens from the British Museum (Natural History).
- (T) Indicates that Wellington Caves is the type-locality (or probable type-locality) of the taxon (see Mahoney & Ride, 1975).
- O.C. Indicates a specimen from the "Old Collection" of the Australian Museum.
- BC Indicates that the taxon is represented in collections made from the Bone Cave by Dawson and colleagues, 1983, 1984.
- CC Indicates that the taxon is represented in collections made from the floor of Cathedral Cave by Dawson and colleagues, 1983, 1984.
- BS Indicates that the taxon is represented in collections made from the Big Sink by Dawson and colleagues, 1983, 1984.

<u>SPECIES</u>	<u>NOTES*</u>
Marsupialia	
F. Thylacinidae	
<i>Thylacinus cynocephalus</i>	e.g. UCMP45183, coll. Marcus, 1954, from Phosphate Mine (V67189); F18660, coll. J. Harvey Truman, 1926; Presence of <i>Thylacinus</i> sp. from Breccia Cave noted by Kreffft (1870). BC, CC, BS.
F. Dasyuridae	
<i>Sarcophilus lanianus</i>	(T) e.g. F31045, coll. Anderson, 1932; UCMP45184, coll. Marcus, 1954 from Breccia Cave; UCMP45182 coll. Marcus, 1954 from Bone Cave. BC.
<i>Dasyurus</i> sp. cf. <i>D. maculatus</i>	e.g. F18897, coll. Anderson & Clutton, 1926. BC
<i>Dasyurus</i> sp. cf. <i>D. viverinus</i> or <i>D. geoffroi</i>	e.g. MF 144, exchanged Mining Museum, 1934. BC.
<i>Phascogale tapoatafa</i>	e.g. F62095, transferred from Mining Museum, ?1964. BS.
<i>Phascogale</i> sp.	e.g. F62103, transferred from Mining Museum, 1964. BC, CC.
<i>Sminthopsis</i> sp. cf. <i>S. murina</i>	e.g. F62097, transferred from Mining Museum, ?1964. CC, BC.
<i>Antechinus</i> sp. cf. <i>A. flavipes</i> or <i>A. stuartii</i>	e.g. F62098, transferred from Mining Museum, ?1964. CC, BC.
Genus indet.	e.g. F62110, F62113, transferred from Mining Museum, ?1964. BC.
F. Peramelidae	
<i>Isoodon</i> sp. cf. <i>I. obesulus</i>	e.g. F57920, O.C., CC, BC.
<i>Perameles</i> sp. cf. <i>P. nasuta</i>	e.g. BM43951, BM42639, presented to BM in 1870 (see Lydekker, 1887; Kreffft, 1870); F57918. O.C., CC, BC.
<i>Perameles</i> sp. cf. <i>P. bougainville</i>	e.g. F18898, coll. Anderson and Clutton, 1926.
F. Thylacomyidae	
<i>Macrotis lagotis</i>	e.g. BM42663, BM43884, presented to BM in 1870 (see Kreffft, 1870 who notes this species — as <i>Peraglea</i> , in Breccia Cave); F57917. O.C.
F. Phascolarctidae	
<i>Phascolarctos</i> sp.	No specimens available. Kreffft (1870) notes <i>P. cinereus</i> from Breccia Cave.
F. Vombatidae	
<i>Vombatus ursinus mitchellii</i>	(T) e.g. BM M10791, holotype, probably from Breccia Cave; MF721, O.C. "Cave 4"; F58707, O.C. "Cave 4"; F31055, coll. Anderson & Schevill, 1932. BC.
<i>Lasiorhinus kreffftii</i>	(T) e.g. BM 42601, holotype, coll. Kreffft, 1866 or 1869 in Breccia Cave.
<i>Phascolonus gigas</i>	e.g. MF728/9, transferred from Mining Museum, 1936.
<i>Ramsayia magna</i>	e.g. F5342, coll. by H. Barnes, 1885.
Genus indet. <i>medius</i>	e.g. UCMP 45148, coll. Marcus, 1954, Bone Cave. BC.

- F. Diprotodontidae
Subfam. Diprotodontinae
Diprotodon optatum (T) e.g. BM M10796, holotype, coll. by Mitchell, 1830, in "the large cave". BC.
Diarcodon parvus (T) e.g. F50099, holotype, coll. J. Mahoney, 1954, in Bone Cave. This taxon is in need of revision.
Zygomaturus trilobus e.g. UCMP LFM124, coll. in Bone Cave by Marcus, 1954.
Subfam. Palorchestinae
Palorchestes azeal e.g. MF452, transferred from Mining Museum, 1936; F7272, holotype *P. rephaim*, coll. Barnes (see Woods, 1958). BC.
Palorchestes parvus e.g. F30646, F30645. O.C.
Palorchestes sp. e.g. F31047, coll. Anderson & Schevill, 1932.
- F. Petauridae
Pseudocheirus sp. e.g. BM M3651 (see Lydekker, 1887).
- F. Phalangeridae
Trichosurus sp. cf. *T. vulpecula* e.g. F62091, F62092 coll. in Bone Cave by Hope, 1963, 1976. Noted in Breccia Cave by Krefft (1870). CC, BC.
- F. Thylacoleonidae
Thylacoleo carnifex e.g. F51287, O.C., labelled "No. 4 Cave" = Cathedral Cave; F4664, coll. H. Barnes, "3 Cave" = Breccia Cave; F18666, coll. Anderson & Clutton, 1926. CC, BC.
- F. Potoroidae
Propleopus sp. e.g. UCMP 45171, coll. in Bone Cave by Marcus, 1954.
Aepyprymnus rufescens e.g. UCMP 45189, coll. in Breccia Cave, Marcus, 1954; F18899, coll. Anderson & Clutton, 1926. CC, BC.
Bettongia sp. e.g. UCMP 57387, UCMP 57388, coll. Wellington Caves (general) by Marcus, 1954.
- F. Macropodidae
Subfam. Sthenurinae
Sthenurus (Sthenurus) atlas (T) e.g. UCMP 45193, coll. Bone Cave, Marcus, 1954.
Sthenurus (Sthenurus) andersoni e.g. UCMP 57373, UCMP 64967, coll. in Wellington Caves (general) by Marcus, 1954.
Sthenurus (Simosthenurus) oreas e.g. F31026, coll. Anderson & Schevill, 1932, BC.
Sthenurus (Simosthenurus) orientalis (T) e.g. F10201, holotype. O.C.
Sthenurus (Simosthenurus) pales (T) e.g. F31041, coll. Anderson & Schevill, 1932.
Procoptodon rapha (T) e.g. F19652, holotype, coll. Krefft, 1869, Breccia Cave; UCMP 57385, coll. Bone Cave by Marcus, 1954.
Procoptodon pusio e.g. F19654, O.C.; Krefft (1870) notes several specimens of *Halmaturus thomsonii* (= *P. pusio*) from Breccia Cave.
Troposodon minor e.g. F31012, coll. Anderson & Schevill, 1932; UCMP 45149, UCMP 45192, coll. in Bone Cave by Marcus, 1954. CC, BC.
Troposodon kentii e.g. F31027, coll. Anderson & Schevill, 1932.
- Subfam. Macropodinae
Bohra paulae (T) e.g. AM F62099, O.C., no precise location data; referred tibia, F62101 from "4 Cave", collected by Ramsay, 1881.
Protemnodon brehus (T) e.g. F43303a, BM 43853, syntypes, coll. Krefft, 1866, 1869 in Breccia Cave; UCMP 54031, coll. in Phosphate Mine by Marcus, 1954. CC, BC.
Protemnodon anak e.g. F18904/9, coll. Anderson & Clutton, 1926. BC.
Protemnodon sp. cf. *P. devisi* Unregistered specimens BS.
Thylogale sp. e.g. MF 304, transferred from Mining Museum, 1935.
Wallabia sp. nov. Unregistered specimens BS.
Macropus sp. cf. *M. giganteus* e.g. MF 124, transferred from Mining Museum, 1934.
Macropus giganteus titan (T) e.g. BM M10777, holotype, from "Large Cavern", coll. by Mitchell, 1830; F18665, coll. Anderson & Clutton, 1926 in Phosphate Mine; UCMP 45164, coll. in Breccia Cave, Marcus, 1954. CC, BC.
Macropus robustus altus (T) e.g. UCMP 45155, coll. in Bone Cave by Marcus, 1954; F31029, coll. by Anderson & Schevill, 1943. BC.
Macropus wellingtonensis n.sp. (T) e.g. F31037, coll. Anderson & Schevill, 1932. BC.
Macropus agilis siva e.g. UCMP 45174, coll. in Breccia Cave, Marcus, 1954. BC.
Macropus rankeni n. sp. (T) e.g. F31015, coll. Anderson & Schevill, 1932. BC.
Macropus sp. cf. *M. dryas* e.g. F47077e, transferred from Mining Museum, 1964.

<i>Macropus</i> sp. cf. <i>M. rama</i>	e.g. F47115, transferred from Mining Museum, 1964.
<i>Macropus</i> sp. I	e.g. MF65, transferred Mining Museum, 1930. BC.
<i>Macropus</i> sp. II	e.g. F31041, coll. Anderson & Schevill, 1932. BC.
<i>Petrogale</i> sp. cf. <i>P. penicillata</i>	e.g. F47033, transferred from Mining Museum, 1964. BC.
<i>Onychogalea</i> sp. cf. <i>O. fraenata</i>	e.g. F31048, coll. Anderson & Schevill, 1932.
<i>Largochestes leporides</i>	e.g. F31044, coll. Anderson & Schevill, 1932. BC.
Genus indet. 1	e.g. MF47, MF63, transferred from Mining Museum, 1930; F30331, F30555. O.C.
Genus indet. 2	e.g. unregistered specimens. BC.

Note: New species mentioned in this list have been described by Dawson (1982), an unpublished Ph.D thesis.

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