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A late nineteenth century collection of fossils from the Naracoorte Caves highlights the role of the South Australian Museum in the history of the site.

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Abstract

The Naracoorte Caves World Heritage site is renowned for its well-preserved deposits of fossil vertebrates spanning the last 500,000 years. Palaeontological research at the Caves began in earnest in 1969 following the discovery of the Fossil Chamber in Victoria Cave. Prior to that, records of fossil discoveries were largely restricted to incidental finds of material during caving activities or cave tourism developments in the Caves Reserve and the broader Naracoorte cave complex. The Reverend Julian Tenison-Woods first reported vertebrate fossils from Naracoorte Caves in 1858. However, there is no record of museum accession for this material and its current whereabouts is unknown. Discovery of megafauna fossil material was widely reported in 1908 and later, but there is very limited information regarding fossil collections made at Naracoorte during the middle to late nineteenth century. Here we report on fossil material collected from Naracoorte Caves and curated at the South Australian Museum by Amandus Zietz in 1888. The collection includes a range of small bones that are labelled and mounted, suggesting they were once used for public outreach or display. These fossils may represent the earliest museum collection currently known from Naracoorte Caves and highlight the South Australian Museum's long association with the caves and the early history of palaeontological investigation at this globally significant locality.

Keywords: Naracoorte Caves, fossils, Amandus Zietz, Quaternary, South Australian Museum, World Heritage.

1.0 Introduction

The Naracoorte Caves in South Australia is renowned for its Quaternary vertebrate fossil deposits (Wells and others 1984; Reed and Bourne 2000, 2009). The site was inscribed on the UNESCO World Heritage list in 1994 with Riversleigh in north-west Queensland as the Australian Fossil Mammal Sites (Riversleigh/Naracoorte). Throughout the Naracoorte cave complex, vast sediment deposits preserve deeply stratified assemblages of fossil vertebrates that span the last 500,000 to 600,000 years (Prideaux and others 2007; Arnold and others 2022; Weij and others 2022). In addition to the vertebrate fossils, multiple palaeoclimate and palaeoenvironmental proxies are preserved, including speleothems, pollen, diatoms, charcoal and macro plant fossils (e.g. Bampton 2021; Atkins and others 2022). Naracoorte's fossils are exceptionally well preserved, with over 135 species of amphibian, bird, reptile and mammal identified to date (Reed 2019). The combination of multiple fossil sites at one locality, diversity of faunal and environmental records and tightly resolved site chronologies places Naracoorte Caves in an ideal position to address key questions relating to Quaternary biodiversity such as the causes and timing of megafauna extinction.

The first written records of caves at Naracoorte come from 1845, soon after European colonisation of the region (Reed and Bourne 2013). Originally known as the Mosquito Plains Caves, they have served as a major visitor attraction for the district and source of pride for the local community (Reed and Bourne 2013). The Naracoorte area holds Cultural significance for First Nations Peoples who have lived in the South East region of South Australia for thousands of years (Reed 2021). The Naracoorte area is the Traditional Country of the Potaruwutij, Jardwadjali, Boandik and Meintangk Peoples. Unfortunately, no archaeological record

has been found in the caves so far, and information on specific interactions with the caves is limited. Our focus for this paper relates to the post-European colonisation history of the Naracoorte Caves, specifically the history of palaeontological study.

In 1857, Reverend Julian Tenison-Woods visited Blanche Cave at Naracoorte and later reported his discovery of fossil bones representing modern species of small mammals in *The South Australian Register* (Woods 1858). However, he did not recover any remains of extinct Pleistocene species, such as those previously found in the Wellington Caves in New South Wales (Reed and Gillieson 2003). Woods later expanded his description of the caves and fossils in his book *Geological Observations in South Australia: Principally in the district South-East of Adelaide* (Woods 1862). Despite providing a detailed account of what he found in the cave, Woods did not mention where the fossil material he collected was housed or if it was presented to a museum for registration. The South Australian Museum (located in Adelaide) became an entity in 1856, yet there is no record of this fossil material in the accession records. Woods may have sought to lodge it with another institution; however, we have not been able to find any record of this. Later records from the early twentieth century indicate that more fossil material had been discovered at Naracoorte Caves, and this was lodged with the South Australian Museum (Turner and Reed 2023). However, there remains a gap in knowledge regarding fossil collections made from Naracoorte during the middle to late nineteenth century.

Here we describe a collection of vertebrate fossils from Naracoorte Caves that is housed in the Palaeontology Collection of the South Australian Museum. The material is attributed to Mr Amandus Zietz, who was a Preparator and Assistant Director of the Museum and is well known for fossil discoveries made with the Museum Director, Edward Stirling. The fossil collection described here contains a selection of small bones accompanied by hand-written labels indicating the material was collected or curated in 1888. Palaeontology collection records indicate that it was retained for its potential historical value. Here we propose that this is the earliest museum curated fossil collection from Naracoorte Caves and present a description of the material and its significance, along with biographical information on Amandus Zietz. We also review early fossil discoveries at Naracoorte and the role of the South Australian Museum in palaeontological research in South Australia and its long association with the Naracoorte Caves.

2.0 The 1888 Zietz collection

2.1 Documentation and curation of the collection

We documented and photographed all individual elements of the collection, including the original packaging. Photographs were taken with a Nikon D7200 digital SLR camera and Nikon 50 mm lens. For each item we recorded the following details: description, size (dimensions in mm), condition and recommendations for conservation. Individual items were placed in an acid-free archival sleeve and then all collection items were placed in the original box with a Tyvek cover sheet and then placed in an acid-free archival storage box within a foam bed. We registered the collection with the Palaeontology Collection of the South Australian Museum and it was given the registration number SAMA P57488 (SAMA = South Australian Museum Adelaide; 'P' refers to the Palaeontology Collection). We documented 27 items which are all included under this registration number.

2.2 Description of the collection - SAMA P57488

The collection consists of a rectangular-shaped cardboard storage box containing 23 cards with small fossil bones glued to them, a glass vial containing cave sediment, and some loose fossil specimens in a small tray with hand-written and printed labels (Figure 1, Appendix). The storage box is a cardboard tray with lid (270 x 207 mm: Figure 2A, B). It is covered with reddish-brown coloured paper with a fine 'pebbled' texture. The tray is in reasonable condition, with bumping on the corners and peeling of the paper cover. It appears consistent in age with the collection, but we cannot confirm the precise association between the box and the contents. Fixed to the front of the tray is a modern white sticker labelled "Naracoorte Caves A. Zietz" in permanent marker (Figure 2C). The tray is lined with cotton wool and tissue which has yellowed with age (Figure 2D).

A small, glass-bottomed tray with white-paper-covered sides was found within the storage box (125 x 87 mm: Figure 3A, B). This style of tray was commonly used at the South Australian Museum for storing collection items in the nineteenth century. It contains loose bone material and some small limestone fragments (Figure 3B). The fossil material is from various small vertebrates, with one long bone fragment from a macropod, which appears to have a small word written in ink that possibly reads 'Zietz". Two hand-written labels and one printed

Figure 1. Contents of the storage box in original position prior to documentation (SAMA P57488). Scale bar = 8 cm.

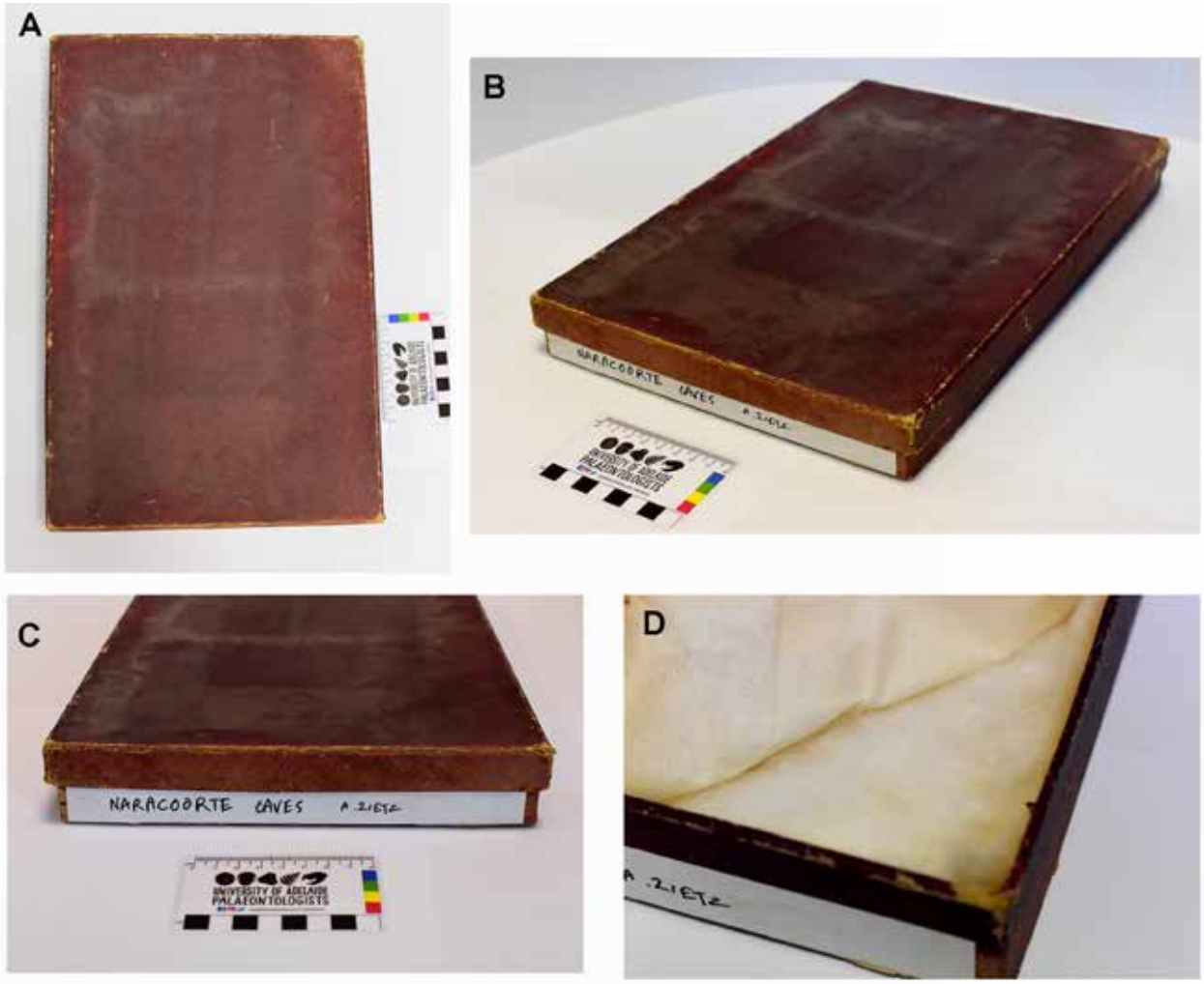

Figure 2. Storage box containing the Zietz material (SAMA P57488). A - view of box lid from above; B - view of entire box; C - front of box showing label; D - cotton and tissue padding lining the base of the box (specimens removed).

Figure 3. Descriptive labels associated with the collection (SAMA P57488). A. Printed label found within a small tray of assorted bones; B. Small tray of assorted bones with hand-written label; C. Hand-written label listing the contents of the collection and locality (signed A. Zietz 1888); D. Rear of label. Note that the preferred spelling of Naracoorte in the 19th Century was 'Narracoorte'.

label are included with the fossil material (Figure 3). The printed label (113 x 87 mm; Figure 3A) reads: "Sample of GUANO from the Narracoorte Caves, containing Bones of small Mammals, Birds, Reptiles, &c.". Note that the spelling of Naracoorte on the label – "Narracoorte" – was actively used in the 19th and early 20th centuries but is no longer in use. Labels such as this were printed in-house at the Museum or by local printers for items that would be exhibited, suggesting this collection may have been on display at some stage. The largest of two hand-written labels (60 x 45 mm; Figure 3C, D) reads: "Bones of various animals: Birds, Rodentia, Marsupialia, Saurians etc. sorted out from samples of dust, which was taken from the Narracoorte Caves. A. Zietz. 1888.". Another smaller label, written on lined paper (35 x 26 mm; Figure 3B), reads: "Narracoorte Caves". All labels, both card and paper, have yellowed with age.

Included in the collection is a glass vial with a cork stopper (Figure 4). It has a hand-written label that reads "Narracoorte Caves" glued to the glass. The vial is 117 x 27 mm and contains a sample of very fine-grain cave sediment which is probably a sample of the sediment from which the fossils were picked. There are 23 individual cards with fossils glued on to them and these range in size from 45 x 28 mm to 114 x 74 mm (Figure 4, Table 1). The cards are in good condition; most are cream-coloured (yellowed with age), but one card is black. The cards have been labelled in pencil, describing the fossils attached (Figure 4, Table 1). Most of the fossils are in good condition, but a few are incomplete, and some are missing from their cards as indicated by glue spots without specimens. Some of the missing specimens were found in the glass-bottomed tray with the various small bones. A range of different small vertebrate bones are represented on the cards and are arranged either by skeletal element type (e.g. pelvis, vertebrae, ribs) or animal type (e.g. mammal, bird). Most of the bones are described using common vernacular such

Figure 4. All items from the collection (SAMA P57488) laid out. Scale bar = 5 cm.

as "shin bones", "arm bones", "leg bones" rather than formal anatomical terms. One card is labelled using the German spelling *Knie* bones rather than 'knee' and suggests Amandus Zietz may have labelled it as he was German (Figure 4). The use of simple terminology for the labels may support the suggestion that the specimens were on public display. The use of cards for display of specimens, known as visible curation, was commonly done in the early history of the South Australian Museum (Neville Pledge pers. comm. 2022). Another possibility, given that the cards are small, is that they were used for teaching, demonstrations or presentations to hand around to participants to inspect.

2.3 The fossil fauna represented in the collection

The fossil collection consists of a range of skeletal elements, mostly mammalian remains and some bird bones. Reptile and frog remains are absent from the collection. Bird bones include some cranial and post-cranial elements. Post-cranial mammalian bones represent much of the collection, with several cranial specimens. Only a handful of the specimens such as maxilla, dentaries and teeth are identifiable to genera or species. The rodents (Muridae) identified include *Pseudomys auritus, Pseudomys* (small, possibly *P. fumeus*) and *Rattus spp.* Marsupial specimens include species

of the family Dasyuridae (e.g. *Sminthopsis spp.*), bandicoots (*Perameles spp.* including juveniles).

The bones and identified animals reflect the composition of many of the Quaternary age small vertebrate fossil deposits at Naracoorte (Reed and Bourne 2000; Macken and Reed 2013). The dominance of mammalian remains, particularly rodents, is characteristic of these deposits (Macken and Reed 2013). The prevalence of small bones and the faunal composition is also suggestive of the accumulating mode in the cave via owl pellets (regurgitates). Owls are well documented as accumulators of small vertebrate remains in caves at Naracoorte in modern times as well as in fossil taphonomic histories from the caves (Reed 2012; Macken and Reed 2013). Owl-pellet-derived fossil deposits form thick units on cave floors at Naracoorte and would have been easily accessible at the time of collection in 1888, particularly in the frequently visited Blanche Cave, which was the site of fossil collection by Woods in 1857.

2.4 Origin of the collection

We have compared the handwriting and signature on the labels with known examples from Amandus Zietz held in the South Australian Museum Archives and State Records of South Australia and it is consistent with his writing. It is unclear whether Zietz collected the fossil material himself or curated a collection submitted to the South Australian Museum by someone else. One of the labels suggests he sorted the bones from samples of cave "dust" (sediment) collected at Naracoorte. Zietz was known to be active in the field and travelled to museums in Melbourne and Sydney to purchase and exchange material including ethnographic and faunal material in late October and November in 1888 (Anon. 1888a; McCoy 1888; Zietz 1888; Turnbull 2017). Frederick McCoy (Director of the National Museum in Melbourne) wrote to Robert Kay (General Director and Secretary of the Public Library, Museum and Art Gallery of South Australia) on 22nd November 1888 to outline Mr Zietz's recent trip, including some details of items for exchange between the two museums (McCoy 1888). There is mention of fossil shells from South Australia, but not of any vertebrate material from Naracoorte Caves. However, it is possible material was acquired by Zietz during this trip, although it is not mentioned in his correspondence (Zietz 1888). We have recently been made aware of a small collection of material from Naracoorte Caves that is housed in the Palaeontology Collections of Museums Victoria and attributed to the collector George Sweet; however, there is no date with this material, making it difficult to align it with the collection discussed here.

In mid-1888, Zietz examined megafaunal fossil material collected from a cave in Mount Gambier in 1887 by Mr Ritter, which had been received as a donation to the Museum via Mr Basedow MP in March 1888 (Anon. 1888b, c). There is a record for the donation of a stalagmite from Naracoorte Caves to the Museum by Mr Lawrence in November or December 1887 (Anon. 1888d). These various donations may have motivated Zietz to visit the South-East region of South Australia and it is entirely possible that he visited the Naracoorte Caves. However, we cannot confirm from Museum travel records that he journeyed to Naracoorte or that he collected any material from Naracoorte Caves.

Zietz may have curated material submitted to the Museum by a member of the public, although we cannot find a donation record to support this. Another possibility is that the material was collected by a 'Collector' for the Museum, a practice that was common at the institution (Hale 1956). One such collector, Frederick William Andrews, had a keen interest in the Naracoorte Caves and he put forward an unsuccessful offer to the Forest Board to "take charge" of the caves in 1879 (Anon. 1879). Andrews was first commissioned as a Collector in 1864 by the Curator, Frederick George Waterhouse, and remained in this role until his tragic death in 1884 (Hale 1956). Anderson may have collected a sample of cave sediment which was later sorted, identified and curated by Zietz. However, we cannot find evidence to support this.

We propose that the fossil material was collected from what is now the Naracoorte Caves World Heritage Area, and possibly from Blanche Cave. In 1876 the caves were transferred to the management of the Forestry Board and declared the Caves Range Forest Reserve. The Forest Board later became the Woods and Forest Department, and in 1885 50 acres of land around the caves was declared as a reserve for the protection of the caves. In 1888, the Caretaker and Forester of the Caves Range Forest Reserve was William Reddan (Reed and Bourne 2013). If the material described in this paper was collected after 1885 then it would have been with permission of the caretaker. The labels use the formal name "Narracoorte Caves", which was used at the time to describe the Reserve. Blanche Cave

(often called Old Cave or Big Cave) was the main cave that people visited at the park and had been since 1845. It is the cave in which Reverend Woods made his fossil discoveries in 1857. Blanche Cave is easily accessible when compared with others such as Bat Cave and Cathedral Cave which have deep vertical entrances. The sediment sample within the glass vial in the Zietz collection closely resembles the dry, fine-grained sandy sediments found on the floor of large chambers in Blanche Cave. It is possible that it came from one of the other caves; however, regardless it is most likely that it would have been collected from within the Caves Reserve at that time. William Reddan may have collected the material himself and forwarded it to the Museum; however, we so far have no evidence to confirm this.

3.0 Amandus Zietz (1839 – 1921) and Friedrich Zietz (1874 – 1922)

Amandus Heinrich Christian Zietz (Figure 5) was born in Schleswig-Holstein in 1839. A well-educated man, he reportedly studied under the famed German zoologist and naturalist Ernst Haeckel (Anon. 1921). His early career was as a teacher, but this was not his main interest, and he later won a museum position at the Godeffroy Museum in Hamburg where he could pursue his passion for collecting. Zietz served as a preparator and curator at the Kiel Zoological Museum where he won awards for exhibitions he had prepared (Anon. 1921).

Doctor Wilhelm Haacke, Director of the South Australian Museum in Adelaide, recommended Zietz for appointment as Preparator. Zietz arrived in South Australia in 1883 (Anon. 1921). He later became Assistant Director, working under Professor Edward Stirling (Hale 1947; Hale 1956). Stirling and Zietz worked closely together and are well-known for expeditions to Lake Callabonna in the 1890s where they recovered fossils of megafauna, notably *Diprotodon optatum* and *Genyornis newtoni*. They published several monographs and papers on these finds (see Hale 1956 for an overview). Assisted by his son Friedrich, Zietz assembled a *Diprotodon* skeleton for display at the Museum (Anon. 1906).

Figure 5. Left. Amandus Zietz c. 1890 (State Library of South Australia B6817). Right. Friedrich Robert Zietz (State Library of South Australia B9387/35).

Amandus Zietz made important contributions to the Museum's collections and exhibitions during his time, particularly with his studies of fish and birds (Hale 1956). He died in Adelaide in August 1921 (Anon. 1921).

Friedrich (Fritz) Robert Zietz (Figure 5), son of Amandus Zietz, was a well-known ornithologist in South Australia. He started working at the South Australian Museum in 1891 as an apprentice and was employed as an assistant in 1897 and later as ornithologist. He was a founding member of the Royal Australian Ornithologists' Union and a Fellow of the Royal Society of South Australia (Anon. 1922). In 1908, he visited Naracoorte Caves with Professor Stirling where he collected megafauna fossil material from Specimen Cave (Anon. 1908; Turner and Reed 2023).

4.0 The role of the South Australian Museum and its palaeontology collections.

4.1 *Involvement of South Australian Museum scientists in fossil discoveries at Naracoorte.*

In 1908, 50 years after Woods first reported bones from Blanche Cave, the park caretaker, William Reddan, discovered some remains of *Thylacoleo carnifex* and other species in Alexandra Cave and Specimen Cave (Reed and Bourne 2000; Turner and Reed 2023). The Director of the South Australian Museum, Edward Stirling, was notified by Reddan and visited the caves with Museum Preparator Friedrich Zietz (Figure 5). They collected material from Specimen Cave which was lodged in the Museum's collections (Anon. 1908; Turner and Reed 2023). Stirling later reported the finds to the South Australian Museum Board (Stirling 1908, 1912). These were the first records of extinct Pleistocene species found at Naracoorte Caves (Turner and Reed 2023) and the first fossil material publicly reported since Woods (1862).

Very little was subsequently reported about fossil collections from Naracoorte's caves until key discoveries were made in the 1950s and 1960s. A skeleton of the Pleistocene marsupial predator *Thylacoleo carnifex* was found in James Quarry (Naracoorte township) in 1956 and reported to the South Australian Museum by the quarry owner, Amos James (Daily 1960). The Curator of Anthropology, Norman Tindale, and Preparator Paul Lawson collected the specimen; a later collection was made in 1957 by Tindale and the Curator of Fossils and Minerals, Brian Daily (Daily 1960). Additional specimens of *T. carnifex* were reported to the Museum in 1959 by Amos James, and Brian Daily and Peter Aitkin (Assistant Curator of Insects) collected further material from the quarry site (Daily 1960). At Naracoorte Caves Reserve, cave exploration led to the discovery of *T. carnifex* material in Cathedral Cave in 1959 and this was accessioned into the Museum collections. The formation of CEGSA (Cave Exploration Group of South Australia) in 1955 led to systematic exploration and mapping of the caves in the South East region and many more fossil discoveries, too numerous to summarise here. CEGSA was affiliated with the South Australian Museum and its members contributed to fossil collections over many years and greatly increased knowledge of the fossil values of South Australian caves.

Pleistocene fossil material was excavated from Haystall Cave in 1964 by CEGSA members, including Neville Pledge, who would become the Curator of Fossils at South Australian Museum in June 1969 (Mitchell 1969). The fossil material was registered with the Museum and some of the extinct sthenurine kangaroo specimens were described by Merrilees (1965). In 1969, a large cave deposit was uncovered during quarrying in Henschke Quarry in Naracoorte Township. Named the Henschke Fossil Cave, the site yielded a diverse array of Pleistocene fossils and was excavated by cavers and volunteers under the direction of Neville Pledge from 1969 to 1981, and later excavated by John Barrie (Pledge 1990; Barrie 1997). Volunteers from the Friends of the South Australian Museum group assisted with the excavations and some of these people joined CEGSA to further their interest in caves (Pledge 1980). In the same year, the most extensive Pleistocene deposit in the region was discovered by cave explorers Grant Gartrell, Roderick Wells and Robert Henzel in Victoria Cave (now known as Victoria Fossil Cave) within the Naracoorte Caves Reserve (Wells 1975; Wells and others 1984). Following the discovery, palaeontologist Rod Wells and colleagues from Flinders University spent several decades excavating and studying the Fossil Chamber deposits and documenting a diverse assemblage of Middle Pleistocene fauna (Wells and others 1984). Volunteers assisted with the excavations and included university students, members of the local community and CEGSA members.

In 1972 the Naracoorte Caves was designated as a Conservation Park and management was transferred

to the National Parks and Wildlife Service (NPWS) under the *National Parks and Wildlife Act 1972* (Wells and others 1980). Funding was acquired in 1974 to improve visitor infrastructure in the cave and build an interpretation centre at park headquarters. Planning and implementation of displays in the centre was a collaborative effort between NPWS, the South Australian Museum, CEGSA and Flinders University (Wells and others 1980). The construction of displays was directed by Museum Preparator, Paul Lawson, and included realistic cave displays moulded from latex peels of the walls in Alexandra Cave. The centre opened in 1979 and remained in operation until it was superseded by the Wonambi Fossil Centre which opened in 1998.

Fossil material from many sites at Naracoorte Caves, collected primarily by researchers from Flinders University and The University of Adelaide, forms a significant component of the South Australian Museum's Quaternary vertebrate fossil collection. The Naracoorte Caves is now internationally recognised as a UNESCO World Heritage site preserving a suite of Quaternary vertebrate fossil deposits spanning 500,000 years. South Australian Museum palaeontology researchers, including one of us (ER) and Diego Garcia-Bellido (Miocene marine fossils) are involved in research and public outreach at the site. The Museum is the responsible agency for the curation of fossil specimens from the Naracoorte Caves as is reflected in the park management plan which states: "These remain the property of South Australia and must be registered with the South Australian Museum" (Department for Environment and Heritage 2001). There is also a South Australian Museum representative serving on the Interagency Reference Group for Naracoorte Caves.

4.2 *Palaeontology at the South Australian Museum.*

The South Australian Museum is the custodian of South Australia's cultural and natural heritage. Legislated to collect and care for zoological and geological specimens, and objects of historical interest *(South Australian Museum Act 1976-1985),* the Museum has been acquiring specimens since 1856, with the purpose of increasing knowledge and understanding of the State's natural and cultural heritage. The Museum has a function to educate the public about the State's natural heritage, scientific research, biodiversity, environment and Aboriginal Culture. The specialised data produced by its staff are available to national and international communities through online databases, public outreach and publications. Its Natural Science Collections play a vital role in documenting Earth's past and present. They are a valuable resource to examine and interpret, expanding current knowledge about the evolution of life. Research outcomes from the fossil collections will elucidate environmental changes linked to climate change thus enabling us to prepare for a sustainable future. Specimens collected over the last 167 years are being re-examined using the latest research technologies to produce new information, such as the use of stable isotope analysis of rodent teeth to reconstruct paleoenvironments (Bampton 2021). Research cannot be adequately undertaken without the collections and their significance as study material is evidenced by access requests for visiting researchers from all over the world. These collections are not only of scientific importance but are also a part of Australia's national heritage.

The Palaeontology Collection dates to the beginning of the Museum in 1856 (originally known as the South Australian Institute Museum). When plans for a museum were announced, colonists and amateur naturalists began donating specimens to populate an establishing institution (Hale 1956). The first recorded discovery of fossil vertebrates was in 1857 by a Thomas Wigley who found bones in the bank of the River Murray which were subsequently shipped to Professor Richard Owen in London for examination (Hale 1956). In 1869 fossils were purchased for £4 "from a quarry near Government House" (Hale 1956). Since then, opportunistic discoveries and donations from members of the public, pastoralists and mining activities provided a rich and diverse South Australian collection. The first Curator of the Museum, Frederick George Waterhouse (1860–1882), acquired material (real and casts) locally and worldwide to entertain and enlighten Adelaideans. This attitude has now shifted to conservation and a greater appreciation of scientific research. Few systematic searches for fossil vertebrates were done by South Australian Museum staff until the Hurst, Stirling and Zietz expeditions in 1893; then later in 1906 by A. Zietz and R. Zietz at Salt Creek/Normanville (Hale 1956). Other noted early expeditions include Stirling and Zietz to Naracoorte in 1908 (Turner and Reed 2023); Tindale's 1931 Tantanoola Caves expedition; followed by the 1953 and 1954 expeditions by Professor Stirton to the Lake Eyre Basin (Hale 1956).

Today, South Australian Museum staff, in collaboration with national and international researchers, continue the methodical search for fossils of national and global significance from South Australian localities such as the World Heritage Naracoorte Caves, the Nilpena Ediacara National Park in the Flinders Ranges, Lake Callabonna and Lake Palankarinna Fossil Reserves, Emu Bay and Kelly Hill Conservation Park on Kangaroo Island and the Nullarbor Plain in South Australia. This ongoing and active research has expanded the collections over decades. The Palaeontology Collection currently has over 59,000 registered specimens and is one of Australia's key repositories of Ediacaran, Cambrian and Quaternary fossil collections. The primary focus is South Australian collections based on contemporary research and collection strengths. Items from outside South Australia are collected if considered necessary for better understanding of regional occurrences and for comparative studies. However, the collecting interests of other museums are respected and consultation with these institutions is undertaken when there are overlapping interests. To this day, the South Australian Museum receives generous donations of specimens from the general community and acknowledges this significant contribution to the State's natural heritage collections.

5.0 Conclusions

SAMA P57488 consists of a collection of vertebrate fossil material from Naracoorte Caves, curated by Mr Amandus Zietz in 1888. The fossil specimens are mostly mounted on cards and accompanied by hand-written and printed labels contained within a cardboard storage box. The collection is in good condition overall and the presence of labels and the mounting of specimens suggests the material may have been on display or used for public outreach at the South Australian Museum. The fossil material represents a variety of small vertebrates typical of Quaternary deposits at Naracoorte Caves. The collection is historically significant as it may represent the earliest accessioned museum collection from the Naracoorte Caves. Previous collections were made by the Reverend Julian Tenison-Woods in 1857, but the whereabouts of this material is unknown and there is no record of museum accession or further discoveries until 1908. The collection is associated with Mr Amandus Zietz who was a Preparator, and later Assistant Director, of the South Australian Museum. Zietz is a significant character in the Museum's history, and the fields of palaeontology and zoology in South Australia.

The material described in this paper highlights the involvement of the South Australian Museum with the Naracoorte Caves over at least the last 135 years, and the important role of the Museum in palaeontological research at this globally important locality. We demonstrate the value of examining undescribed museum collections which may yield important historical information about fossil localities. The South Australian Museum is a key institution for palaeontological research in South Australia and its collections span the extensive history of life on earth recorded in the diverse fossil sites of the State.

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Author contributions

ER, JBT and MAB devised the study. ER and JBT documented the collection and identified the fossils. ER undertook archival research and wrote most of the manuscript with contributions from JBT and MAB. JT contributed historical research to the project. All authors contributed to editing the manuscript.

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APPENDIX - List of items registered in the 1888 Zietz collection SAMA P57488.

Item no.	Item	Size (mm)	Description	Label text (exact transcription)
1	Storage box with lid and cotton padding.	270 x 207 x 30 (tray); 280 x 219 (lid)	Small glass-bottomed tray of fossil bones; glass vial filled with cave sediment; 23 cards with bones glued to them	Naracoorte Caves. A. Zietz
2	Label	60 x 45	Label written in ink on card	Bones of various animals: Birds, Rodentia, Marsupials, Saurians etc. sorted from samples of dust, which was taken from the Narracoorte Caves. A. H. Zietz 1888
3	Tray of loose bones with two labels	125 x 87 (tray), 113 x 87 (printed label); 35 x 26 (label)	Glass bottomed tray containing loose fossil bones and two labels - one printed and the other hand-written on lined paper	1. Sample of GUANO from the Narracoorte Caves, containing Bones of small Mammals, Birds, Reptiles &c.; 2. Narracoorte Caves
4	Glass vial with cork stop	117 x 27	Glass vial containing sample of cave sediment. Cork stopper	Narracoorte Caves
5	Card with small bones glued on	60 x 45	Calcaneus; small mammals. 12 specimens	No label
6	Card with small bones glued on	90 x 60	Cranial bones and teeth, small mammals	Marsupial Narracoorte Caves
7	Card with small bones glued on	60 x 45	Manus and pes elements, small mammals; two caudal vertebrae. 42 specimens	Footbones etc Narracoorte Caves
8	Card with small bones glued on	90 x 60	Vertebrae - small mammal, bird, and frog. 30 specimens	Vertebra Narracoorte Caves
9	Card with small bones glued on	90 x 60	Bird bones - cranial and post-cranial. Three specimens	Bird Narracoorte
10	Card with small bones glued on	114 x 74	Rodent bones - dentaries and isolated teeth. 18 specimens	No label
11	Card with small bones glued on	60 x 45	Tibia - small mammals. Four specimens	Shinbones of small mammals Naracoorte Caves
12	Card with small bones glued on	45 x 28	Pelvis and scapula - small mammals Five specimens	No label
13	Card with small bones glued on	60 x 45	Epiphysis - small mammals. 24 specimens	No label
14	Card with small bones glued on	60 x 45	Ulna - small mammals. 11 specimens	Arm bones of small mammals Narracoorte Caves
15	Card with small bones glued on	75 x 55	Pelvis, sternum, fragments - small mammals. Eight specimens	Pelvis etc. Narracoorte Caves

16	Card with small bones glued on	60 x 45	Metatarsal - small mammals. Three specimens	No label
17	Card with small bones glued on	45 x 30	Patella - small mammals (bandicoot). 10 specimens	Knie bones Narracoorte
18	Card with small bones glued on	90 x 60	Sacrum, vertebrae - small mammals. 10 specimens	Sacrum vertebra of small mammals Narracoorte Caves
19	Card with small bones glued on	90 x 60	Vertebra (cervical, thoracic) - small mammals. 13 specimens	vertebra Narracoorte Caves
20	Card with small bones glued on	90 x 60	Vertebra (caudal + others) - small mammals. 50 specimens	tailbones of small mammals Narracoorte Caves
21	Card with small bones glued on	90 x 60	Tibia - small mammals. Four specimens	Shinbone of mammals. Narracoorte Caves
22	Card with small bones glued on	90 x 60	Petrous - small mammals 17 specimens	Earbones of small mammals Narracoorte Caves
23	Card with small bones glued on	60 x 45	Rib - small mammals. 12 specimens	ribs Narracoorte Caves
24	Card with small bones glued on	55 x 40	Molar teeth - small mammals. 19 specimens	molars of small Marsupials Narracoorte Caves
25	Card with small bones glued on	60 x 45	Humerus - small mammals. Two specimens	legbones of small mammals Narracoorte Caves
26	Card with small bones glued on	90 x 60	Cranial fragments - small mammals. 30 specimens	Skull bones Narracoorte Caves
27	Card with small bones glued on	90 x 60	Femur, humerus - small mammals. Five specimens	Leg bones of small mammals Narracoorte Caves