Vol. 5, No. 2 JANUARY, 1967 PRICE 50c.

Helictite

JOURNAL OF AUSTRALASIAN CAVE RESEARCH

Helictites in the Number Two Extension, Temple of Baal, Jenolan, N.S.W. Photo: A. Healy.

Registered in Australia for transmission by post as a periodical.

"HELICTITE"

Journal of Australasian Cave Research

Edited by Edward A. Lane and Aola M. Richards

VOLUME 5, NUMBER 2 Published Quarterly JANUARY, 1967

CONTENTS

Price of this issue: To non-subscribers, $A 1. Additional copies to subscribers, 75c. Included in yearly subscription, 50c. Subscription $A 2 per annum, post paid. All subscriptions taken on basis of full volume of four issues. Correspondence, contributions and subscriptions to "Helictite", Box 183, Post Office, Broadway, New South Wales, Australia. "Helictite" is printed and published by E.A. Lane. "Helictite" is registered in Australia for transmission by post as a periodical.

ABSTRACTS

PALYGORSKITE IN A CAVE IN NEW ZEALAND. By D.C. Lowry. N.Z. J. Geol. Geophysics, 7 (4), 1964 : 917.

PALYGORSKITE OR MOUNTAIN LEATHER? Anon. N.Z. Speleo. Soc. Bull., 51 (Vol. 3), 1965 : 276 - 278.

The clay mineral, palygorskite, is identified from several caves in the Te Kuiti area of the North Island of New Zealand. This is believed to be the first reported occurrence of the mineral in New Zealand. The mineral occurs as white absorbent sheets 5 mm thick of fine matted fibres filling vertical joint openings in limestones of the Te Kuiti Group (Lower to Middle Oligocene). Lowry describes the occurrence and hypothesises that evidence in the area where he collected specimens shows that the passage once lay beneath the watertable and the joints probably filled with palygorskite at the time. A previous specimen collected by an unnamed person in 1956 was misidentified in 1960 as "mountain leather", a variety of amphibole or asbestos. Lowry collected the next specimen in 1961 and this was identified as palygorskite. X-ray examination by the Government Chemical Laboratories of Western Australia has also shown that the mineral belongs to the palygorskite (attapulgite) group of clay minerals. - E.A.L.

ARCHAEOLOGICAL EXCAVATIONS IN NEW GUINEA : AN INTERIM REPORT. By J.P. White. J. Polynesian Soc., 74 (1), 1965 : 40 - 56.

A record of inspections of 85 caves and shelters in the Eastern Highlands District, New Guinea, with main reference to excavations in Aibura Cave (limestone cave) in the Lamari River Valley, and Niobe Shelter (a shelter formed by a limestone overhang and probably the minor entrance to a major cave system) near Chuave. Findings include flakes and chips of stone, polished stone axe blades, bone tools, club heads, mortars, shell, ochre, food remains (animal bones), and human remains. More than 100 paintings are reported in Aibura Cave made in two techniques - lines of white dots forming a design, and white smears, often outlined with charcoal. During excavation in the cave, an old man arrived uninvited and made a painting in the cave using the dot technique. The need for detailed ethnographic and anthropological study of the paintings is suggested. The archaeological work gives some confirmation of a cultural break between the eastern fringes and the rest of the Highlands. - E.A.L.

NOTICE

In this and future issues of Helictite, honours and degrees will no longer be placed after the names of authors. Only names and addresses will be given. This is in keeping with the practice of most scientific journals.

DISCOVERY OF A THYLACINE (TASMANIAN TIGER) CARCASE IN A CAVE NEAR EUCLA, WESTERN AUSTRALIA

DAVID C. LOWRY* and JACOBA W.J. LOWRY

(*Geological Survey of Western Australia)

Abstract

A well-preserved carcase of a Tasmanian tiger (*Thylacinus*) was found in October, 1966, in Thylacine Hole (N63), a cave 68 miles west of Eucla in Western Australia.

Introduction

On the mainland of Australia, thylacines are known only as fossils, and although they were common in Tasmania in the early part of this century they are now possibly extinct or at most very rare. Fragmentary remains of thylacines have been recorded from various caves in the limestone of the Eucla Basin (e.g., Cook, 1963). In October, 1966, the authors discovered the carcase of a thylacine with much of the skin and hair intact, and in a much better state of preservation than any previously found on the mainland. The carcase was recovered from the cave with the assistance of Mr. G.W. Kendrick (Western Australian Museum) and Dr. A.E. Cockbain (Geological Survey of Western Australia). The thylacine and other material from the cave is on permanent loan to the Museum from the Geological Survey.

Location and Description of the Cave

The cave is 68 miles west of Eucla, on Mundrabilla Station, 12 miles northwest of the homestead (Figure 1). Its entrance is at grid reference 580077 on the Eucla 1:250,000 sheet, and is located on aerial photograph Eucla run 6 number 5171 (1961 photography), 2.29 inches below and 1.93 inches left of the centre point when the photograph is oriented with north upwards. The entrance is a circular hole three feet in diameter, set in a rock pavement at the base of a depression four feet deep and 25 feet across. The cave is named Thylacine Hole and is registered as N63 with the Cave Exploration Group of South Australia. The cave has a near-vertical entrance shaft three to six feet in diameter and 38 feet deep. At the base, the cave opens out in all directions. Exploration is usually limited, not by definite walls, but by the roof and floor gradually wedging together. The cave is roughly "L" shaped and is 500 feet across (Figure 1). It reaches a maximum depth of 90 feet in a spacious clay-floored chamber 240 feet west of the entrance. The roof is generally low and tends to follow the topography of the floor. Flat clay floors occur in the lowest parts of the cave, but elsewhere the floor consists of fallen blocks of limestone. There is relatively abundant calcite formation (Plate 2), as well as halite straw stalactites and "flowers" (Plate 2).

Bone Material

Near the entrance there is a large amount of owl-pellet deposit - mainly derived from bandicoots, murids (indigenous or introduced rats and mice), small dasyurids (marsupial native cats), and small reptiles. Further from the entrance were the carcases, skeletons and scattered bones of animals which had died in the cave. These included snakes, lizards, birds, murids, bats, a cat, dogs (?dingoes), rabbits, possums, kangaroos, wallabies, thylacines, native cats, a wombat, and a Tasmanian devil.

Flood waters have disturbed the material near the entrance, and elsewhere in the cave some of the bones appeared to have been disturbed by murids. Many of the skeletons were coated with a tarry substance which is probably the remains of soft tissue. The mummification of several of the carcases is probably related to rapid desiccation. On October 23, 1966, the air temperature in the main chamber was 66°F and the relative humidity 67 percent, and although this is cool and humid compared with day-time conditions on the surface, a few scattered measurements indicate that it is warm and dry compared with other caves in the area.

The material was easily visible since it lay on the floor or in cracks in the floor, and it is unlikely that much material was overlooked. A small excavation made in the clay floor in the lowest part of the cave showed that this deposit is devoid of bones. Thus there is little scope for further collecting in this cave.

The cave has acted as an animal trap because it would be difficult for animals to climb out of the cave once they had fallen in. Birds also may have been trapped by losing their way once they were out of sight of light from the entrance. One of the problems is to explain why such a large number of animals should have entered such a small hole. A partial explanation might be that once one animal had fallen in by accident, the smell of its decomposition would be carried by air blowing out of the cave, and so attract carnivores to the entrance. This might be the reason for the very high proportion of carnivores to herbivores (both in numbers and species) in the cave.

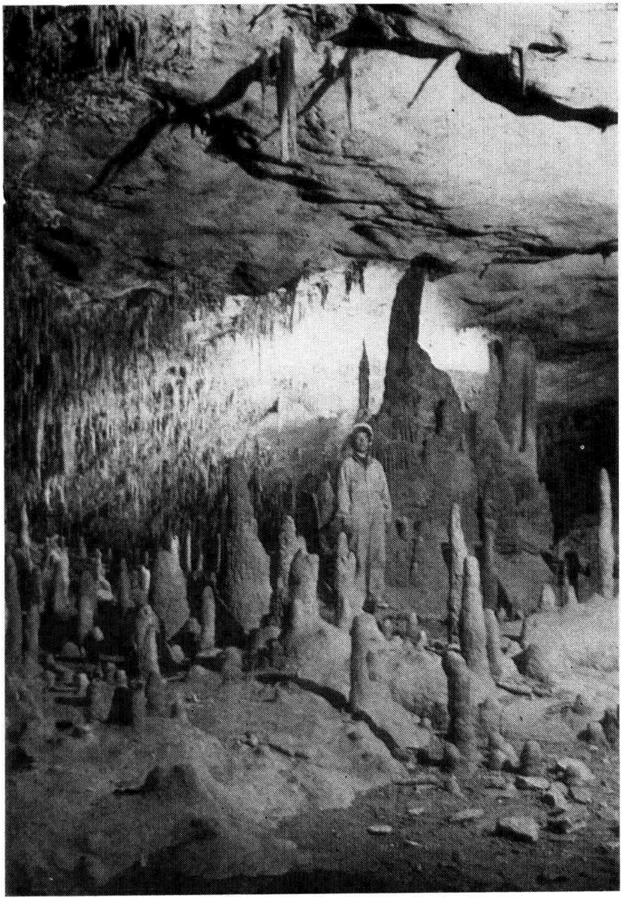
The Thylacine Carcase

The most significant of the remains is a well-preserved carcase of a thylacine. It was found some 450 feet from the entrance on top of a rock pile. The animal lay on its right side with its head raised off the ground (Plate 1). The skin and hair were largely intact on the exposed surfaces,

PLATE 1

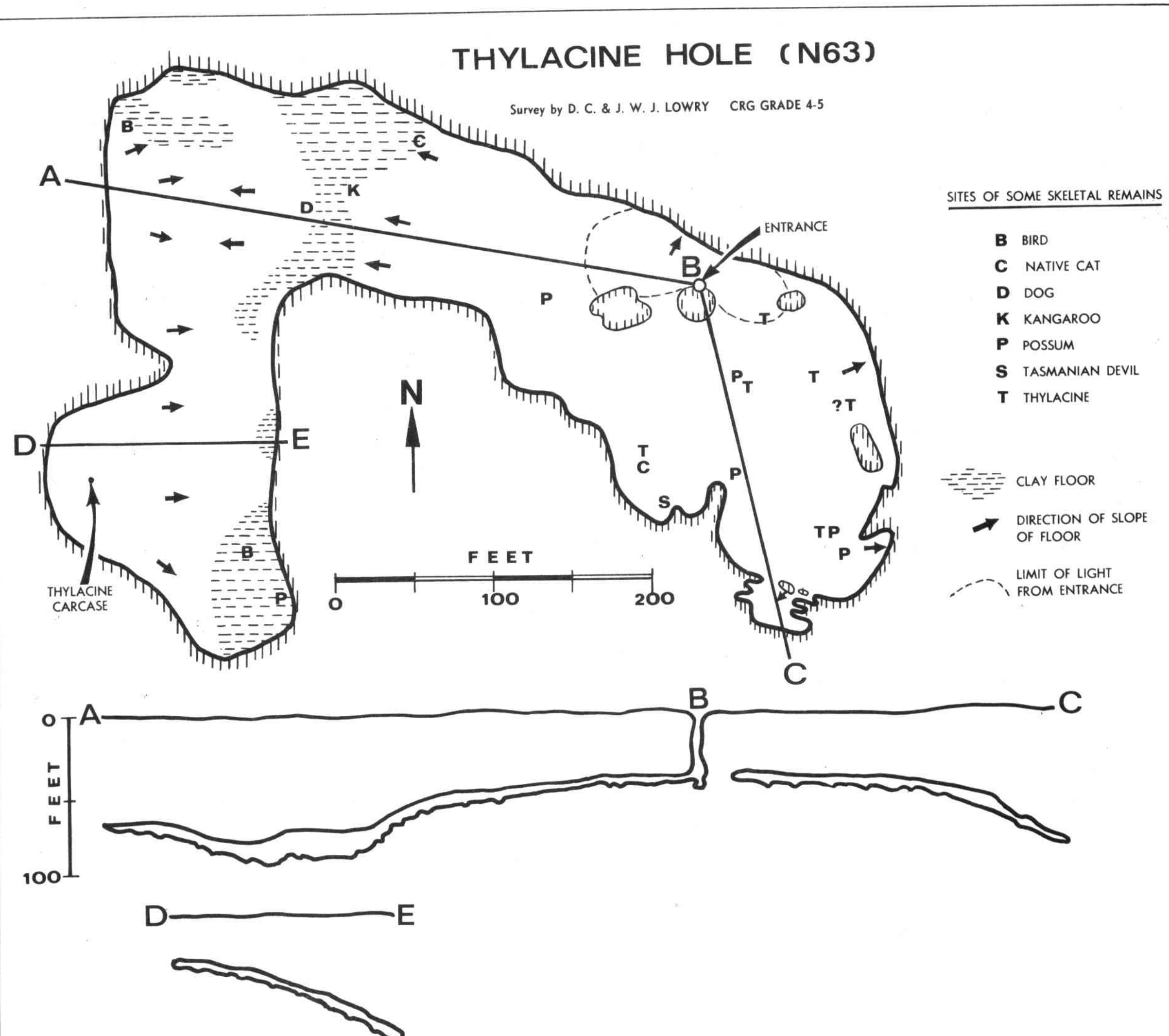
Thylacine
Carcase,
Thylacine Hole (N63),
October, 1966

PLATE 2



Left: Thylacine Hole showing dead calcite speleothems.

Right: Halite flowers in Thylacine Hole.


THYLACINE HOLE (N63)
Survey by D. C. & J. W. J. LOWRY CRG GRADE 4-5
SITES OF SOME SKELETAL REMAINS
B BIRD
C NATIVE CAT
D DOG
K KANGAROO
P POSSUM
S TASMANIAN DEVIL
T THYLACINE
CLAY FLOOR
DIRECTION OF SLOPE OF FLOOR
LIMIT OF LIGHT FROM ENTRANCE
ENTRANCE
THYLACINE CARCASE
FEET
0 100 200
N
FEET
0
100

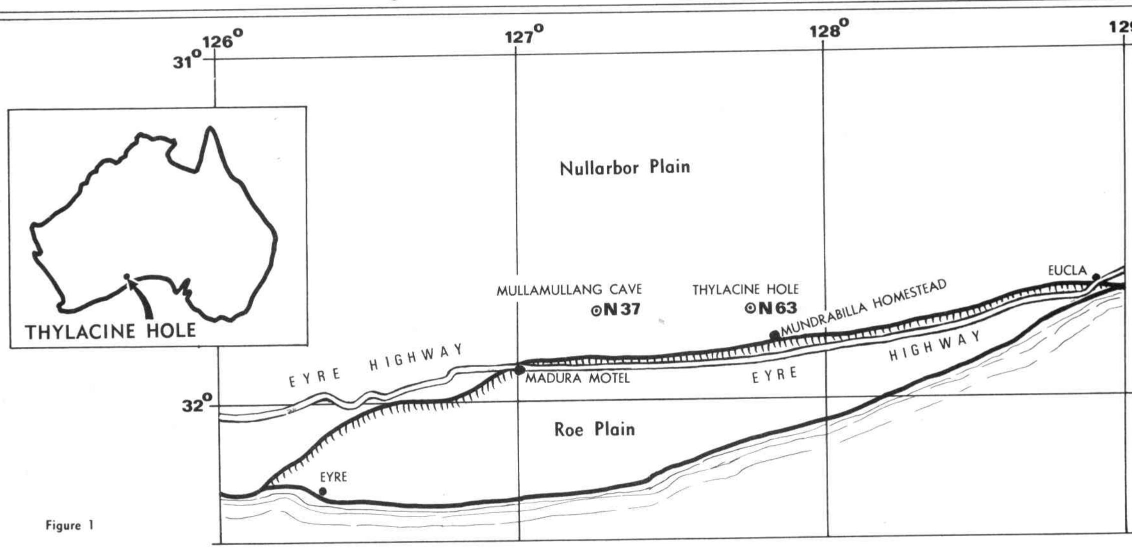

126°
127°
128°
129°
31°
32°
Nullarbor Plain
Roe Plain
MULLAMULLANG CAVE
N37
THYLACINE HOLE
N63
MUNDRABILLA HOMESTEAD
EUCLA
EYRE HIGHWAY
MADURA MOTEL
EYRE HIGHWAY
EYRE
THYLACINE HOLE

Figure 1

and the characteristic dark bars were clearly visible. The soft tissue had decomposed to a tarry substance which coated the exposed bones, and the legs broke readily at the joints during the initial examination. However, the tongue and left eyeball were still recognisable, and a musty odour of decomposition was noticeable. The tail was some 12 inches away from the rest of the body, probably moved there by murids which appeared also to have chewed at the abdomen. Blow-fly pupal cases and faeces (probably murid) were scattered around the carcase.

Significance

Until now it has been possible only to compare the skeletal remains of fossil thylacines from the mainland of Australia with modern skeletons from Tasmania, but with this individual it should be possible to compare other parts such as the hair and the pads of the feet with modern Tasmanian specimens.

Speculative estimates of the age of the carcase range from less than one year to 2,000 years, and a radiocarbon date is being undertaken to determine it accurately. Whatever its precise age, it is evident from this discovery that thylacines persisted on the mainland much later than previously thought. The extinction of the thylacine on the mainland is commonly attributed to competition with the dingo for available prey. Thylacine and dog (presumably dingo) remains were found in a similar state of decomposition in this cave, suggesting that the two species co-existed on the Nullarbor Plain. Dingoes have lived on the mainland for at least 3,000 years (Macintosh, 1964), so the species probably co-existed for several thousand years. If the thylacine was displaced by competition with the dingo, the process was very slow in this area.

Also of significance is the recovery of five other thylacine skulls, some with fairly complete post-cranial parts. Ride (1964) has shown that of the specimens available, thylacines from the Nullarbor Plain and the southwest of Western Australia are generally smaller than those from the Eastern States and Tasmania, but that statistically, the difference is not sufficiently great to warrant subdivision into two species. The study of six skulls from the one locality should throw further light on the taxonomy of this genus.

Acknowledgment

We wish to thank Mr. D. Merrilees (Western Australian Museum) who planned the recovery of the carcase and helped prepare this paper.

References

COOK, D.L. 1963 : Thylacinus and Sarcophilus from the Nullarbor Plains. W. Aust. Naturalist, 9 : 47 - 48.

MACINTOSH, N.W.G. 1964 : In Mulvaney, D.J., Lawton, C.R. and Twidale, C.R. Archaeological Excavation of Rock Shelter No. 6 Fromm's Landing South Australia. Proc. Roy. Soc. Vic., 77 : 479 - 516.

RIDE, W.D.L. 1964 : A Review of Australian Fossil Marsupials. J. Roy. Soc. W. Aust., 47 : 97 - 131.

ooooooooooo

A B S T R A C T S

LAVA CAVES OF VICTORIA. By C.D. Ollier and M C. Brown. Bull. Volcanologique, Tome XXVIII, 1965 : 15 pp. + 4 plates.

Many lava tunnels are found in the Western District of Victoria. They are associated with eruptions of Pleistocene to Recent age. Some are probably only a few thousand years old. Original features of these caves are often preserved in fine detail, but insufficient time for erosion permits only the caves and upper portion of the flow to be studied. Cave features are summarised, e.g., size, shape, ornamentation and cross section. The relationship between the caves and enclosing lava is discussed. The authors believe the caves were formed in two stages. (1) Lava became separated into solid and liquid components. The liquid occupied tubes in the solid lava, completely filling them, and flowed along the tubes which branched and anastomosed but were generally orientated in the direction of flow. (2) The liquid lava was partially or wholly drained out of the tubes leaving empty tunnels (or caves) behind. The field evidence is discussed and a mechanism of formation postulated. The final form of the lava cave depended on the viscosity of the lava flow before withdrawal, the amount of withdrawal, the rate of solidification, and pressure changes in the liquid both before and after withdrawal. Partial collapse and weathering have affected the present day appearance of the caves. - E.A.L.

HURLEYA KALAMUNDAE n.g. n.sp. (AMPHIPODA, GAMMARIDAE) FROM SUBTERRANEAN WATERS OF WESTERN AUSTRALIA. By Milan Straskraba. Internat. J. Speleo., 2 (3), 1966 : 291 - 295.

A new genus and species of freshwater Gammaridae (Amphipoda), Hurleya kalamundae, is described from subterranean waters of Western Australia. The genus represents an aberrant line of the Crangonyx group of Gammaridae. This is the second subterranean Amphipod known from Western Australia. - A.M.R.

BURRAMYS PARVUS BROOM, A LIVING FOSSIL

E. A. LANE* and AOLA M. RICHARDS**

One of the most exciting recent zoological discoveries was the capture alive in August, 1966, of a small possum previously believed to be extinct. It was found in a ski hut at Mt. Hotham, Victoria, by Dr. K. Shortman of the Walter and Eliza Hall Institute. Mr. R.M. Warneke, Senior Research Officer of the Fisheries and Wildlife Department, Victoria, is keeping it alive at the Department's laboratories in Melbourne.

The possum has been identified as the supposedly extinct species *Burramys parvus* Broom. It has no common name. The little animal is about 11 inches long with a six inch tail. It has soft brown-grey fur on the back which is darker along the midline, especially the head. The underparts are creamy in colour. The body is stout and the limbs short, but the tail is very long and thin (Plate 3). It resembles the long-tailed *Cercartetus* of northeast Queensland and New Guinea. Examination of its teeth under partial anaesthesia has revealed the long straight incisors and huge cutting premolars of *B. parvus*. However, definite confirmation of its identity will not be possible until after examination of the skull (Anon., 1966***). This is another example of a relict species which has managed to survive in an isolated area. The alpine environment where it was found is rigorous.

Burramys parvus was originally described by Broom (1896a; 1896b) from a small bone breccia deposit at the Wombeyan Caves in New South Wales. Broom described the deposit as "situated in a small depression near the top of the hill above the present caves", and he considered it to be a portion of the floor of an older cave whose walls and roof had long since been weathered away. He described the stone as very hard, having imbedded in it innumerable small bones, with the remains of a few stalactites and an occasional calcite rhomb. In parts of the breccia, the bones were almost all small and packed together so closely that there was very little matrix; in others the matrix was comparatively free from bones, only containing a few of the larger forms. The bones were mostly those of small marsupials, though there were also the remains of at least one species of rodent, and the very perfect cranium of a small bird. Most of the species he considered belonged either to extinct species or to species no longer living in the district. *Burramys parvus* was one of the most interesting

---

* Australian Atomic Energy Commission, Sydney.

** School of Biological Sciences, University of New South Wales, Sydney.

*** This report in *Nature* incorrectly attributed the capture to Mr. Warneke.

PLATE 3

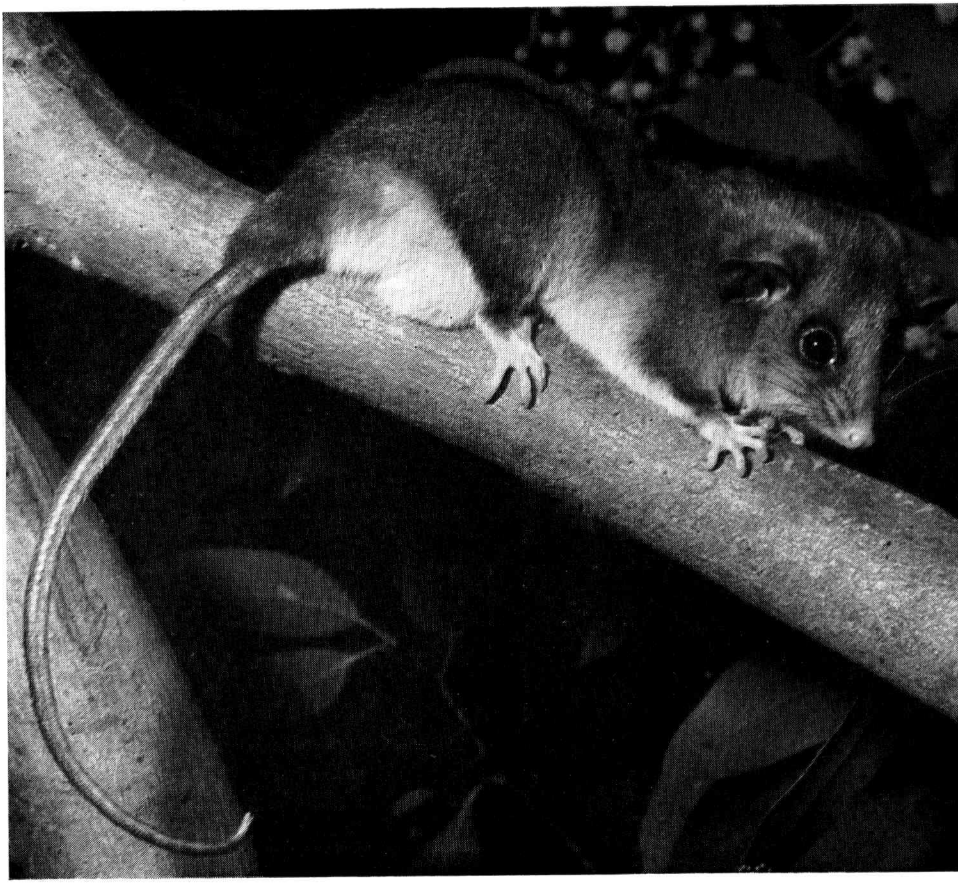


Photo: Fisheries and Wildlife Department, Victoria.

BURRAMYS PARVUS BROOM

forms in the breccia, occurring abundantly in the deposit. As its dentition was unlike that of any known marsupial, Broom placed it in a new genus calling it after the aboriginal name of the district. The description was based on "five or six moderately good lower jaws, the anterior portion of another, and three fragments of the upper." Broom considered the deposit to be of considerable age, and suggested the fossil remains indicated a fauna living in late Tertiary times or the Pleistocene.

Because of its remarkable very large premolars, which closely resemble those of Hypsiprymnodon Ramsay, a very primitive member of the Macropodidae (kangaroos), and of Propleopus Longman, the giant Pleistocene rat-kangaroo, Broom described Burramys as a phalanger possessing characters intermediate between those of the phalangers and kangaroos, thus forming a link between them. He thought it was probably most closely related to the rat-kangaroos, and thus a possible ancestor of the Macropodidae; but it was also "probably very closely allied to the small Phalanger from which Thylacoleo is descended." Tate (1948) decided to remove Burramys from the Phalangeridae, and he placed it in the Macropodidae.

Several years later, Ride (1956) re-examined Broom's original material, plus additional material collected by Broom from the same breccia, and he concluded that Burramys parvus did not belong to the Macropodidae, and was not ancestral to them. He considered the resemblances to Hypsiprymnodon were the result of convergence, and the suggested affinities with Thylacoleo (marsupial lion) were without adequate foundation. Instead he placed Burramys in the Phalangerinae, because its similarities with Eudromicia (pigmy possum), Cercaertus, and Petaurus (gliders) prevented it being placed in a separate monotypic subfamily. Ride probably means Cercartetus Gloger (pigmy possum) and not Cercaertus Burmeister which had been synonymised with Trichosurus Lesson (brush-tailed possum) a number of years before (Iredale and Troughton, 1934). In 1964, Ride concluded that Burramys was a member of an aberrant line of Phalangerinae possessing some relatively unspecialised characters, as well as some very specialised ones.

In 1948, S.J. Copland and E.A. Lane, working from Broom's description of the locality, re-located the area of bone breccia high on the Kooringa-Wollondilly-Guineacor Caves ridge a few feet above the entrance to the Guineacor. At the time, a fair quantity of bone breccia still remained in situ. Discarded breccia chips, mixed with soil and other materials, were heaped nearby, and additional pieces of breccia were observed down the nearby Guineacor Cave entrance shaft. The site was then shown to the recently-appointed Wombeyan Caves Reserve caretaker, Clyde Stiff.

Six years later, R.A. Stirton, H.O. Fletcher, F.W. Booker and J. Connell collected additional fossil bones from the same site at Wombeyan. The deposit was described (Anon., 1954) as situated in a small depression on the hillside "just above the opening of a cave" which was not named in the report. The matrix of the breccia was hard and contained innumerable small bones very closely packed together. Stirton believed that the small bones were originally derived from an accumulation of owl pellets.

In 1960, Ride also visited Broom's locality at the Wombeyan Caves. He describes the type locality for B. parvus as a small pocket of breccia in what was probably a solution pipe at one side of a depression on the top of the ridge. This depression is an old cave floor and is littered with typical cave debris. The solution pipe containing the breccia is within ten yards of a sink-hole called the Guineacor Cave. As the cave floor and the Burramys breccia appear to be much older than the nearby Guineacor Cave, Ride calls them "Broom Cave" and "Broom faunal assemblage" (Ride, 1960), as reference to the Guineacor Cave as the type locality would be misleading. Today very little of the breccia remains on the original site.

Cave breccias have long been well known from many parts of Australia, and many Pleistocene and sub-modern mammals have been described from them. Great concentrations of small bones such as occur in the Burramys breccia are a familiar feature. However, little is known of absolute ages, or even of their ages relative to each other. Until areas can be radiocarbon dated for absolute age, faunal comparisons still provide the most workable basis on which to base relative ageing. In the case of Burramys at Wombeyan, insufficient bone and no plant remains are available for C 14 dating. However, Ride (1960) concludes that the paleoclimatic evidence (which indicates a slightly colder and wetter climate than the area has today) suggests when taken in conjunction with the nature of the fauna, an age somewhat later than the last pluvial period of the Pleistocene. As no detailed geomorphological studies have been made of this cave area, it is difficult to comment on this conclusion. However, the suggested age of the bones appears to be too recent to be consistent with the topography.

In 1960, a collection of bones was made from the Pyramids Cave, in the vicinity of the Murrindal River near Buchan in East Gippsland, Victoria. Wakefield (1960) described the bones, and amongst them identified jaws and other bones as belonging to Burramys parvus. Some of the bones in the collection were reddish in colour and some white. Wakefield believes that a time interval is likely between the respective accumulations of red and white bone material in the Pyramids Cave. The white bones give a picture of a population of small mammals in the Buchan area a hundred or more years ago. The red material represents a community of animals that was there still earlier - probably thousands of years ago. All the Pyramids Cave B. parvus material studied was reddish in colour.

Attention must be drawn also to the similarity of deposition of Burramys bones at Wombeyan and Murrindal. In both cases it has been attributed to owls capturing the animals as food, bringing them back to their lair, and then discarding the bones.

A new locality for Burramys has recently been described by Lundelius and Turnbull (1965; 1967). While excavating on the Grange Burn near Hamilton in Western Victoria, in 1963-64, a small assemblage of marsupial teeth and poorly preserved bone fragments were recovered from a fossil soil developed on near shore sediments of Pliocene age. A basaltic lava flow overlies this soil which contains carbonised roots and stumps. The lava flow is considered to have cremated a living forest and this demonstrates the contemporaneity of the fossil specimens with a potassium/argon date obtained from a sample of the basalt. The isotopic determination of 4.35 million years confirms the Pliocene date of the fauna based on the stratigraphy. In a report to the National Science Foundation, Turnbull and Lundelius summed up the significance of the radiometric dating of the Grange Burn material as follows: (1) It provided a check on the stratigraphic age of the area; (2) it provided a firm tie to the world-wide chronology; and (3) it provided the first positively dated pre-Pleistocene fauna for Australia (Nelson, 1965).

Among the fossils which have been identified is a new species of Burramys, differing from the Burramys parvus of Wombeyan and Murrindal. This new species is considered to be more primitive than B. parvus.

Mr. E.D. Gill, of the National Museum of Victoria, discovered the Grange Burn site about 1952, finding a single mammalian tooth in a fossil soil outcrop, which he identified as a cuscus. This discovery led Lundelius and Turnbull to investigate the area.

With the discovery that Burramys parvus is almost certainly still alive, the range for the genus can now be said to extend over nearly four and a half million years. This is indeed one of the most interesting members of our marsupial fauna.

Acknowledgments

The authors wish to thank the Fisheries and Wildlife Department, Victoria, for permission to reproduce their photograph of Burramys parvus.

References

ANON. 1954 : Fossil Remains from Wombeyan Caves. Aust. Mus. Mag., XI (7) : 221.

ANON. 1966 : A Relict Marsupial. Nature, 212 : 225.

BROOM, R. 1896a : On a Small Fossil Marsupial with Large Grooved Premolars. Proc. Linn. Soc. N.S.W., 10 : 563 - 567.

BROOM, R. 1896b : Report on a Bone Breccia Deposit Near the Wombeyan Caves, N.S.W. : With Descriptions of Some New Species of Marsupials. Proc. Linn. Soc. N.S.W., 21 : 48 - 61.

IREDALE, T., TROUGHTON, E. Le G. 1934 : A Check-list of the Mammals Recorded from Australia. Memoir VI. Aust. Mus., Sydney.

LUNDELIUS, E.L., Jr., TURNBULL, W.D. 1967 : Pliocene Mammals from Victoria, Australia. Abstract of unpublished paper read before Section C, 39th. Cong., ANZAAS, Melbourne, Vic., January, 1967. (Content used here with permission of the authors.)

NELSON, P.R. 1965 : Australian Expedition Discovers Landmark Fossil Site. Chicago Nat. Hist. Mus. Bull., 36 (4) : 4 - 6.

RIDE, W.D.L. 1956 : The Affinities of *Burrumys parvus* Broom a Fossil Phalangeroid Marsupial. Proc. Zool. Soc. Lond., 127 : 413 - 428.

RIDE, W.D.L. 1960 : The Fossil Mammalian Fauna of the *Burramys parvus* Breccia from the Wombeyan Caves, New South Wales. J. Roy. Soc. W. Aust., 43 : 74 - 80.

RIDE, W.D.L. 1964 : A Review of Australian Fossil Marsupials. J. Roy. Soc. W. Aust., 47 (4) : 97 - 131.

TATE, G.H.H. 1948 : Studies on the Anatomy and Phylogeny of the Macropodidae (Marsupialia). Bull. Amer. Mus. Nat. Hist., 91 : 237 - 351.

TURNBULL, W.D., LUNDELIUS, E.L., Jr., McDOUGALL, I. 1965 : A Potassium/Argon Dated Pliocene Marsupial Fauna from Victoria, Australia. Nature, 206 : 816.

WAKEFIELD, N. 1960 : Recent Mammal Bones in the Buchan District. Vict. Nat., 77 : 227 - 240.

00000000000

A B S T R A C T

A FOSSIL BONE DEPOSIT NEAR PERTH, WESTERN AUSTRALIA, INTERPRETED AS A CARNIVORE'S DEN AFTER FEEDING TESTS ON LIVING *SARCOPHILUS* (MARSUPIALIA, DASYURIDAE). By A.M. Douglas, G.W. Kendrick and D. Merrilees. J. Roy. Soc. W. Aust., 49 (3), 1966 : 88 - 90.

Carcases of marsupials have been fed to living specimens of the Tasmanian Devil (*Sarcophilus harrisi*) and the bony content of these carcases has been recovered. The kinds of damage inflicted by *Sarcophilus* on bone have been compared with damaged bone from an old cave deposit near Wanneroo, in the vicinity of Perth, Western Australia. This deposit contains remains of *Sarcophilus*, and it is concluded that the deposit represents the den or feeding place of *Sarcophilus*, probably of late Quaternary age.

COCKROACHES (BLATTODEA) FROM AUSTRALIAN CAVES

AOLA M. RICHARDS

Zoology Department, University of New South Wales, Sydney

Abstract

Ten species of Australian cockroaches are recorded from Australian caves and mines. Most are troglophiles or guanobia. Only one troglobitic species is known. The distribution of these species is given, and attention is drawn to their absence from south-eastern Australia and Tasmania. It is suggested that climatic changes in the Pleistocene and early Recent may have been responsible for this, and that the fauna found in many cave areas may be of comparatively recent origin.

Introduction

Cavernicolous cockroaches occur in caves in tropical regions throughout the world. They have been collected from North Vietnam, Malaysia, northeast India, the Philippines, east Africa, the Congo, Madagascar and Texas (U.S.A.). Up to 1954, 33 species of Blattodea had been recorded from caves (Chopard, 1954), but of these only a very few can be regarded as true cavernicoles.

Excluding the trogloxenes, Vandel (1965) has divided cave-dwelling cockroaches into three groups - troglophiles, guanobia and troglobites. The majority of cockroaches found in caves he considers are troglophiles, and show little modification for life in caves. A large number are also found associated with guano. These forms are well pigmented and possess eyes.

A few species are regarded as intermediate between troglophiles and troglobites. Of particular interest are the genera _Alluaudellina_ Chopard, with species from Tanganyika and northeast India; and _Nocticola_ Bolivar, with species from the Philippines and Madagascar. There is loss of pigment in these forms, also elongation of legs, cerci and antennae. In _A. cavernicola_, males range from fully-winged or macropterous forms with well-developed eyes, through various stages to micropterous forms with short elytra and wings reduced to small lobes, and with eyes reduced to three ommatidia. Wings and elytra are absent in females and the eyes are very reduced. This species is in a state of morphological instability, and Vandel considers it a very clear example of regressive evolution. As _A. cavernicola_ has also been found under rocks in bamboo forest (Jeannel, 1943), it has been concluded that it is a troglophile and not a troglobite. *A. himalayensis* also occurs on the surface as well as in caves.

Only two troglobitic cockroach species have been described. Both belong to the genus *Spelaeoblatta* Bolivar and both occur in Burma. *S. caeca* and *S. gestroi* are depigmented, without eyes and ocelli, are completely apterous, lacking both wings and elytra, and have very long antennae, legs and cerci (Chopard, 1921). They are the most modified cavernicolous cockroaches known.

Chopard (1932) has placed the genera *Alluaudellina*, *Nocticola* and *Spelaeoblatta* in the subfamily Nocticolinae, thus uniting a group of widely distributed cavernicolous forms from the Philippines, Malaysia and east Africa which closely resemble one another.

Until recently, little was known about the cavernicolous Blattodea of Australia. Now cockroaches have been collected from a number of caves in eastern, southern and western Australia (Figure 1). Many of these specimens are nymphs and, at this stage of our knowledge, cannot be identified with certainty. Among areas yet to be examined are the Kimberleys in the northwest of Western Australia, and caves near Katherine in the Northern Territory. As interest in the cavernicolous insect fauna of Australia increases, the distribution of cockroaches is sure to be extended.

At the present time, the Australian Blattodea are being revised by M.J. Mackerras (1965a, 1965b, 1965c, 1966a, 1966b). She has examined the cavernicolous material, and so far has identified eight species, belonging to six genera in two of the four families of Blattodea - the Blattidae and the Blattellidae. She considers only one of these species to be a troglobite. The rest are trogloxenes, guanobia or troglophiles and are usually strongly pigmented with well developed eyes.

The following list incorporates Mackerras' identifications with all other available information on Australian cavernicolous cockroaches, and increases the number of species recorded from caves to ten.

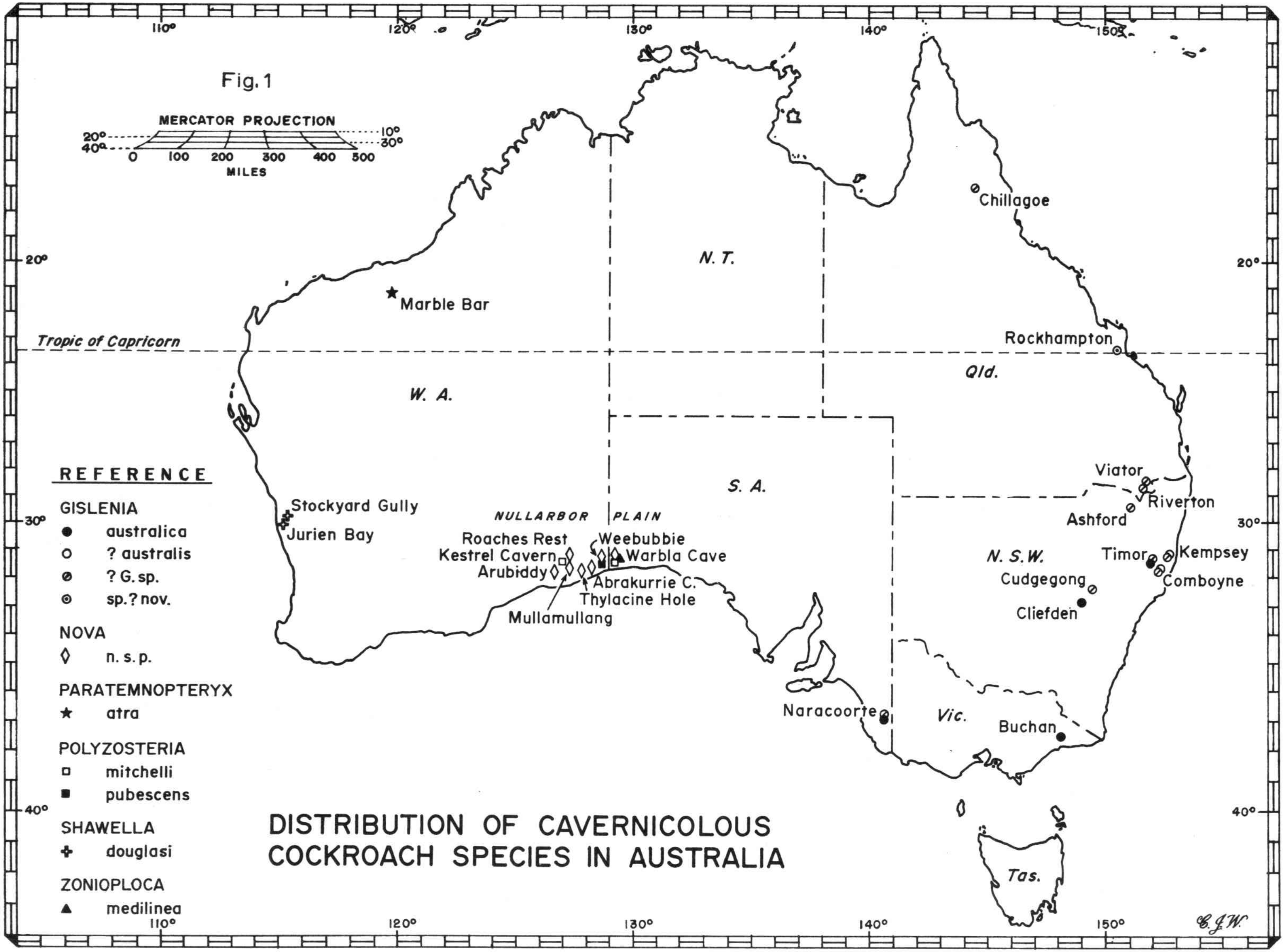
CHECKLIST OF AUSTRALIAN CAVERNICOLOUS BLATTODEA

Order BLATTODEA
Suborder BLATTOIDEA
Family BLATTIDAE
Tribe POLYZOSTERIINAE

POLYZOSTERIA Burmeister, 1838.

P. mitchelli (Angas, 1847).

P. pubescens Tepper, 1893.



DISTRIBUTION OF CAVERNICOLOUS COCKROACH SPECIES IN AUSTRALIA

ZONIOPLOCA Stal, 1874.

Z. medilinea (Tepper, 1893).

Suborder BLABEROIDEA
Family BLATTELLIDAE
Tribe PARCOBLATTINI

GISLENIA Princis, 1954.

G. australica (Brunner, 1865).

G. ?australis (Saussure, 1863).

Gislenia sp. ?nov.

?*Gislenia* sp.

GENUS NOVA.

Species Nova.

PARATEMNOPTERYX Saussure, 1869.

P. atra Princis, 1963.

SHAWELLA Princis, 1951.

S. douglasi Princis, 1963.

Family BLATTIDAE

Tribe POLYZOSTERIINAE

Cavernicolous species have been recorded from only two genera in this family.

Genus POLYZOSTERIA Burmeister, 1838.

The distribution of this genus ranges from northern New South Wales, through Victoria and South Australia, to Western Australia. Fifteen species, all apterous, have been placed in it, and of these only two have been recorded from caves (Mackerras, 1965a).

Polyzosteria mitchelli (Angas, 1847).

This is another primarily epigean species which extends from Victoria, across South Australia to Western Australia. It has been collected from two caves on the Nullarbor Plain, but shows no signs of cave adaptation.

Cave Locality. SOUTH AUSTRALIA: Warbla Cave, Nullarbor Plain. WESTERN AUSTRALIA: Kestral Cavern (near Madura), Nullarbor Plain.

Polyzosteria pubescens Tepper, 1893.

This species is distributed across the surface of the Nullarbor Plain, and has been collected also from one of the limestone caves. The cavernicolous form shows no sign of cave adaptation.

Cave Locality. WESTERN AUSTRALIA: Weebubbie Cave, Nullarbor Plain.

Genus ZONIOPLOCA Stal, 1874.

This genus is distributed throughout southern Australia, and is associated with mallee and spinifex country. Nine species belong in this genus, and only one of these occurs in caves (Mackerras, 1965c).

Zonioploca medilinea (Tepper, 1893).

The only known cave record for this species is from Warbla Cave on the Nullarbor Plain, although epigean specimens have been taken near Cocklebiddy Caves. It shows no signs of cave adaptation.

Cave Locality. SOUTH AUSTRALIA: Warbla Cave, Nullarbor Plain.

Family BLATTELLIDAE

Tribe PARCOBLATTINI

Four genera with cavernicolous species belong in this tribe.

Genus GISLENIA Princis, 1954.

This genus has not yet been revised by Mackerras, and its distribution throughout Australia is not known. The range of cavernicolous forms extends from northern Queensland, through New South Wales and Victoria, to just across the South Australian border. In most cases they are guanobia, although some are troglophiles. Most specimens collected have been nymphs, so in many cases identification remains doubtful until adult insects are collected. Mackerras (pers. comm.) has separated the cave material into four groups, but this will need revision at a later date.

Gislenia australica (Brunn., 1865).

The cave distribution of this species extends from central New South Wales, through Victoria to South Australia. Apart from reduction of wing size in the female, there are no signs of cave adaptation. The material examined consisted of one macropterous male, six micropterous females and five nymphs.

Cave Locality. NEW SOUTH WALES: Glendue Cave, Timor; Murder Cave, Cliefden. VICTORIA: Mabel Cave, East Buchan. SOUTH AUSTRALIA: Bat Cave and Haystack Cave, Naracoorte.

Gislenia ?australis (Sauss., 1863).

This species appears to be confined to northern New South Wales caves, and so far has been recorded from two localities only. Seven males have been collected, but females and nymphs are unknown.

Cave Locality. NEW SOUTH WALES: Cave 4, Comboyne; Temagog Cave, Kempsey.

Gislenia sp. ?nov.

So far the only known locality for this species is the Mt. Etna Caves, Rockhampton. The insects were found some considerable distance from the cave entrances. Two adult females and five nymphs have been collected. The male is unknown, and more specimens are required before the species can be described. There are no signs of cave adaptation.

Cave Locality. QUEENSLAND: Johannsens Cave and Stairway Cave, Mt. Etna, Rockhampton.

?Gislenia sp.

Twenty-one nymphs, which cannot be identified with certainty, are placed under this heading. They have been collected from nine caves ranging in distribution from northern Queensland to central New South Wales, and also just across the South Australian border. Many are guanobites. Specimens from Ashford Cave in northern New South Wales, and Riverton and Viator Caves just across the Queensland border, all show loss of pigmentation. The nymphs from Alexandra Cave, Naracoorte, are troglophiles. No bats occur in this cave. Cockroaches are present in large numbers breeding in the cave, but show no sign of cave adaptation.

Cave Locality. QUEENSLAND: Royal Arch Cave, Chillagoe; Riverton Cave and Viator Cave, Queensland/N.S.W. border. NEW SOUTH WALES: Ashford Cave, Ashford; Cave 4, Comboyne; Hill Cave, Timor; Moparabah Cave, Kempsey; Swallow Cave, Cudgegong. SOUTH AUSTRALIA: Alexandra Cave and Bat Cave, Naracoorte.

Genus NOVA

This is a monotypic genus which contains the only troglobitic cockroach so far recorded from Australia. A full description will shortly be published by Mackerras, who (pers. comm.) considers it is closely related to Gislenia. It appears to be restricted to caves on the Nullarbor Plain.

Species Nova.

This species was first discovered in January, 1965, and is quite common in several caves. Its elytra are short and the wings vestigial, the legs and antennae are elongate, and the eyes completely absent. There is no loss of pigment. The female is the largest cockroach so far recorded from Australian caves, having a body length of about 4 cm. The male is much smaller. Although the species is considered a troglobite, cave adaptation has not progressed to the extent recorded for Spelaeoblatta.

Cave Locality. WESTERN AUSTRALIA: Abrakurrie Cave, Arubiddy Cave, Mullamullang Cave, Roaches Rest Cave and Thylacine Hole, Nullarbor Plain. SOUTH AUSTRALIA: Warbla Cave, Nullarbor Plain.

Genus PARATEMNOPTERYX Sauss., 1869.

Of the four species in this genus, only one has become established in a subterranean habitat (Princis, 1963).

Paratemnopteryx atra Princis, 1963.

This species has been collected deep inside mines at Marble Bar, Western Australia, where it was associated with bat guano. It has not been recorded from the epigean region. It shows no signs of cave adaptation, and is considered a guanobite. Males, females and nymphs are all known.

Cave Locality. WESTERN AUSTRALIA: Mines at Marble Bar.

Genus SHAWELLA Princis, 1951.

Only one species in this genus shows any signs of cave adaptation (Princis, 1963).

Shawella douglasi Princis, 1963.

This species is a Western Australian form. It has been collected from limestone caves at Jurien Bay and Stockyard Gully, and is not known from the epigean region. It was found in association with bat guano. It has moderately reduced eyes, vestigial wings, and weak pigmentation and chitinization of the integument. Princis (1963) considers it is a true guanobite, which may be showing signs of troglobitic development. He described the species from a male and three nymphs. Two brachypterous females have recently been identified by Mackerras (pers. comm.).

Cave Locality. WESTERN AUSTRALIA: Drover's Cave, Jurien Bay; Cave No. 1, Stockyard Gully.

Discussion

Of the two families of Blattodea with cavernicolous representatives, one appears to show much stronger tendencies towards cave adaptation than the other. The Blattidae are widespread over the greater part of Australia, many living in the arid and semi-arid parts of the continent. Cavernicolous forms show no variations from epigean forms, and appear to have colonised caves on the Nullarbor Plain in comparatively recent times. Their apterous condition is not related to their cave habitat.

In the Blattellidae various stages of cave adaptation occur leading up to the troglobitic species. Of the three cavernicolous species of Gislenia from which adults are known, G. ?australis and Gislenia sp. ?nov. are long-winged normal forms from Queensland and northern New South Wales.

Wing dimorphism occurs in the third species, G. australica. Micropterous females of this species have been collected from caves at Timor, Cliefden, Buchan and Naracoorte, and a macropterous male has been taken at Timor. It would be interesting to determine if these populations are each made up of macropterous and micropterous forms in both sexes. The discontinuous distribution of this species suggests that its ancestors must have formed a continuous interbreeding population across south-eastern Australia. There do not appear to be any tendencies towards speciation or subspeciation as a result of isolation, but the sample examined is inadequate. A knowledge of the distribution of epigean forms should help to clarify the distribution pattern for the species. A study of the genetics of these isolated cave populations could also prove of interest. It is doubtful if the micropterous condition in females constitutes a tendency towards cave adaptation.

It is possible that Shawella douglasi and the troglobitic Nullarbor species are survivors from the Tertiary fauna of southern Australia. Unfavourable climatic conditions in the Pleistocene may have forced them to take refuge in, and become established in the caves of south-western Australia. Both are brachypterous, and show other signs of cave adaptation, including degeneration or loss of eyes. Today they have a relict distribution in the caves. The nearest living relatives of the troglobitic species occur in caves at Naracoorte, about a thousand miles to the southeast.

The present broad pattern of climate over Australia appears to have been the same in the Tertiary as now, but the southern part of the continent was warmer, and the area of rainfall in the south and east was wider and wetter than now. During the Pleistocene there was a succession of wet and dry phases, but a large part of the continent was relatively dry, even when rainfall was heaviest (Darlington, 1965). Glaciation was very limited. Part of central Tasmania, and a small area in the Snowy Mountains of New South Wales were under permanent ice, and surrounding areas were subjected to very rigorous temperature conditions (Galloway, 1965).

Moore (1964) considers the arid conditions of the Pleistocene led to the extinction of many hygrophilous plant and animal communities. Darlington (1965) has also suggested that decreasing rainfall, rather than changes in temperature, influenced those portions of the old Tertiary fauna and flora of southern Australia which did survive, forcing them to withdraw either into the cooler south-eastern part of Australia and Tasmania, or into subtropical and tropical northern New South Wales and Queensland. It seems likely that cockroaches, being essentially tropical or warm-temperate insects, were unable to adjust to the climatic fluctuations in southern Australia, and either became extinct or moved north. Today they appear to be completely absent from caves in southern New South Wales. There is only one record - a single female from Buchan caves - for the whole of Victoria, and Naracoorte is the only known locality record in eastern South Australia. The absence of bats, and also the cool cave temperature (c. 48°F), may be partly responsible for their failure to enter Tasmanian caves.

Of the eight genera of epigean Blattidae so far revised by Mackerras (1965a, 1965b, 1965c, 1966a, 1966b), no species occur in Tasmania, and only two alpine species of Polyzosteria are established in the Australian Alps, P. viridissima in New South Wales, and P. metallica in Victoria. However, epigean species are normally distributed throughout western Victoria and South Australia.

This suggests that cockroaches found in many Australian caves are of comparatively recent origin, having colonised caves only after more favourable climatic conditions permitted them to become established in these areas. Because of this, they show few signs of adaptation to cave life, most being troglophiles or guanobia.

Material Examined

Specimens of Gislenia examined by Mackerras are now housed in the Australian National Insect Collection, Canberra; the Australian Museum Collection, Sydney; and the South Australian Museum Collection, Adelaide.

Collectors

The following people have assisted by collecting material recorded in this paper: P.F. Aitken, E.G. Anderson, K. Angell, C. Carter, H. Dengate, B. Dew, P.D. Dwyer, E. Hamilton-Smith, G.S. Hunt, D.C. Lowry, J.W. Lowry, A.M. Richards, R.C. Shepherd, R. Webb, I.D. Wood.

Acknowledgments

I am most grateful to Dr. M.J. Mackerras, Division of Entomology, C.S.I.R.O., Canberra, for examining and identifying the cave cockroach material, for giving me this opportunity to record the present state of our knowledge in this field and to include material as yet unpublished.

References

CHOPARD, L. 1921 : On Some Cavernicolous Dermaptera and Orthoptera from Assam. Rec. Indian Mus., XXII.

CHOPARD, L. 1932 : Un cas de microphthalmie liée à l'atrophe des ailes chez une Blatte cavernicole. Soc. ent. Fr. Livre du Centenaire. Paris.

CHOPARD, L. 1954 : Contribution à l'étude des Orthoptèroides cavernicoles. Notes biospéol., IX.

DARLINGTON, P.J. 1965 : Biogeography of the Southern End of the World. Harvard University Press, Cambridge, Mass.

GALLOWAY, R.W. 1965 : Late Quaternary Climates in Australia. J. Geol., 73 (4) : 603 - 618.

JEANNEL, R. 1943 : Les Fossiles Vivants des Cavernes. Fifth edition. Paris, Gallimard. See Ch. VIII.

MACKERRAS, M.J. 1965a : Australian Blattidae (Blattodea). I. General Remarks and Revision of the Genus *Polyzosteria* Burmeister. Aust. J. Zool., 13 : 841 - 882.

MACKERRAS, M.J. 1965b : Australian Blattidae (Blattodea). II. Revision of the Genus *Euzosteria* Shelford. Aust. J. Zool., 13 : 883 - 902.

MACKERRAS, M.J. 1965c : Australian Blattidae (Blattodea). III. Revision of the Genera *Zonioploca* Stal and *Eppertia* Shaw. Aust. J. Zool., 13 : 903 - 927.

MACKERRAS, M.J. 1966a : Australian Blattidae (Blattodea). IV. *Megazosteria* gen. nov. and Revision of the Genus *Desmozosteria* Shelford. Aust. J. Zool., 14 : 305 - 334.

MACKERRAS, M.J. 1966b : Australian Blattidae (Blattodea). V. Revision of the Genera *Anamesia* Tepper and *Pseudolampra* Tepper. Aust. J. Zool., 14 : 335 - 363.

MOORE, B.P. 1964 : Present-Day Cave Beetle Fauna in Australia, a Pointer to Past Climatic Change. Helictite, 3 : 3 - 9.

PRINCIS, K. 1963 : Two New Western Australian Cockroaches. Roy. Soc. W. Aust., 46 : 11 - 12.

VANDEL, A. 1965 : Biospeleology. The Biology of Cavernicolous Animals. Oxford, Pergamon Press. See Ch. XII.

00000000000