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Helictite

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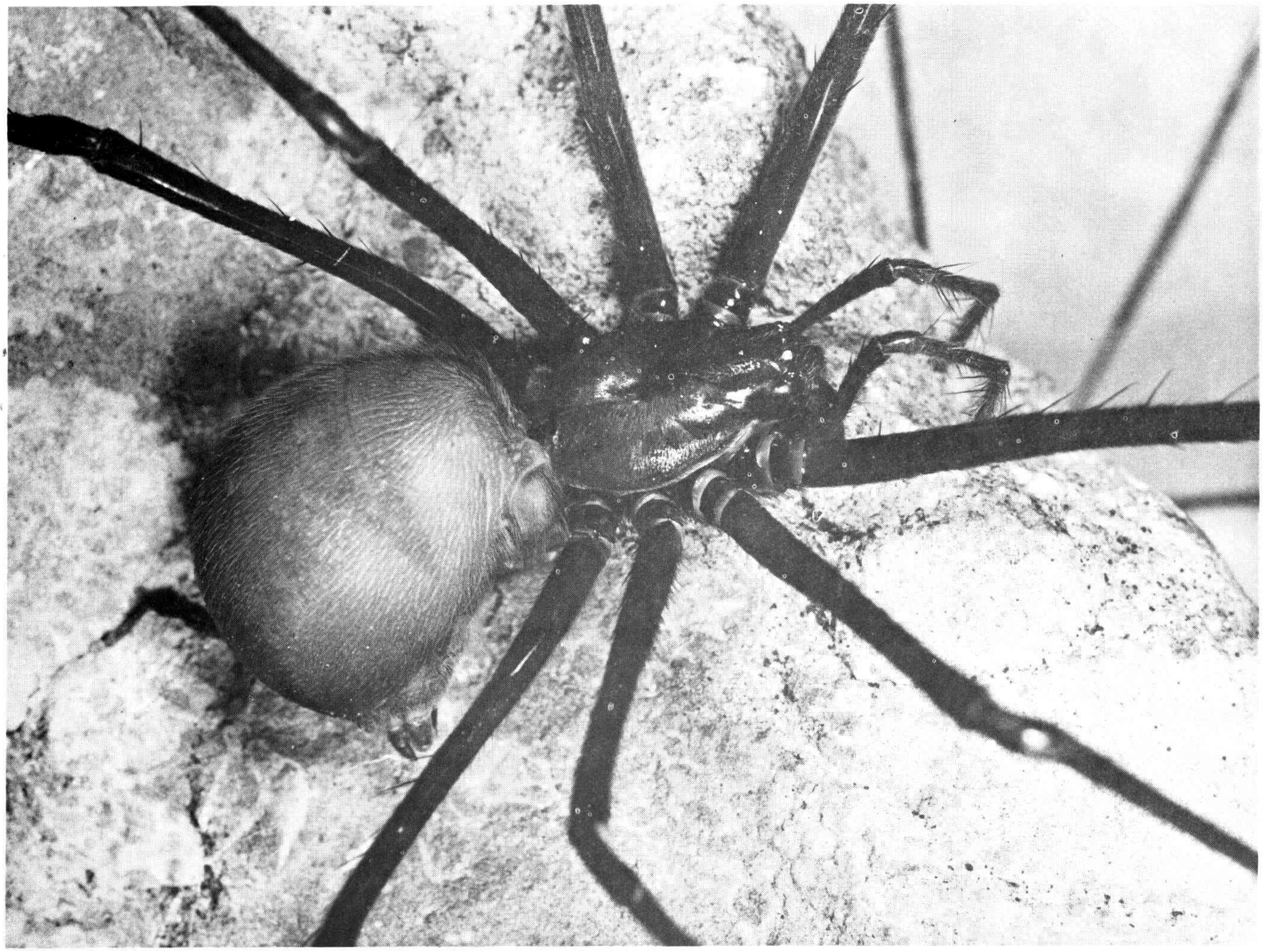

BODY OF FEMALE TASMANIAN CAVE SPIDER
FROM CASHION CREEK CAVE,
FLORENTINE VALLEY, TASMANIA.

Phote: A. Healy.

Registered in Australia for transmission by post as a periodical.

"H E L I C T I T E"

Journal of Australasian Cave Research

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ABSTRACTS

RADIOCARBON DATES FROM NEW GUINEA. By Susan Bulmer. J. Polynesian Soc., 73 (3), 1964 : 327 - 328.

The first radiocarbon dates for prehistoric materials from New Guinea are recorded here. They were obtained from five carbon samples from a rock shelter at the entrance to an extensive series of limestone caves at Kiowa, near Chuave Government Station, Eastern Highlands Division, and approximately 5,000 ft above sea level. H.M. Van Deusen recorded in J. Mammal., 44 (2), 1963 : 279 - 280 (See Helictite, 4 (1), 1965 : 22) that the left half of a mandible of Thylacinus (Tasmanian wolf) was excavated from the floor of this shelter.

Van Deusen advises (pers. comm.) that carbon sample Y1368 in Bulmer's paper from level 10 (10 ft deep), fire ash, is from the same layer as the thylacine bone. The carbon dating of the ash is given as 9,920 + or - 200 years before 1950.

The date from level 12 (10,350 + or - 140 years before 1950) for scattered charcoal, provides the earliest evidence of human firemaking and tool manufacture on the site. This early New Guinea date is further support for the thesis of a late Pleistocene age for human settlement of the then connected Australian-New Guinea landmass. - E.A.L.

FREE LIVING MITES (ACARINA) IN AUSTRALIAN CAVES. By E. Hamilton-Smith. Bull. Nat. Speleo. Soc., 28 (2), 1966 : 100 - 103.

This paper would have had far greater significance if "Free Living" had been left out of the title and abstract, and if a reference to habits, as free living, parasitic, or both, had been included under each group. Of the nine families listed, almost half are characteristically parasitic. The subclass, or order Acarina is not defined by the common name "mites". The Acarina also includes the "ticks" (Ixodides), a distinctive suborder of animal parasites, which are mentioned in this paper. Several taxonomic errors occur through failure to consult relevant literature. It is misleading to put Phytoseiidae in brackets as though synonymous with Ichthyostomatogasteridae, when the latter is based on a single genus taken out of the Phytoseiidae. The name Tyroglyphidae can no longer be used, as the type genus Tyroglyphus was not only sunk in synonymy some years ago, but was also placed by the International Commission on Zoological Nomenclature on its Official Index of Rejected and Invalid Names in Zoology. Acaridae is the accepted name for the family. - A.M.R. (Acknowledgment for comments and discussion is given to Dr. Phyllis Robertson, University of New South Wales, Sydney).

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TASMANIAN CAVE FAUNA : CHARACTER AND DISTRIBUTION

A. GOEDE

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Abstract

The geology and nature of the caves is discussed. Cave development has been affected by glacial outwash and periglacial conditions which must be taken into account when considering the development and distribution of cave fauna. The food supply in the caves is limited by the absence of cave-inhabiting bats. Floods while adding to the food supply must be destructive to some forms of terrestrial cave life. The cave fauna consists entirely of invertebrates. The carab genus *Idacarabus* Lea contains the only troglobites found in Tasmania. A common troglophile throughout the Island is *Hickmania troglodytes* (Higgins and Petterd) which belongs to a very small group of relict spiders. Five species of cave crickets are known from Tasmania and Flinders Island. Three species belong to the genus *Micropathus* Richards and show an interesting distribution pattern. A single species of glow-worm, *Arachnocampa* (*Arachnocampa*) *tasmaniensis* Ferguson occurs in a number of Tasmanian caves. It is more closely related to the New Zealand species than to glow-worms found on the Australian mainland. Other terrestrial cave life is briefly discussed. Aquatic cave life is poorly known. The syncarid *Anaspides tasmaniae* (Thomson) has been recorded from several caves. It differs from epigean forms in reduction of pigment.

Introduction

Cave life in Tasmania has not been studied systematically, but enough is known already to suggest that a closer look would be very rewarding. The Tasmanian cave environment differs in several important aspects from that of mainland Australia. Cave-inhabiting bats are entirely absent from the Island, although three cave-inhabiting species are found in Victoria. Their absence means that food supplies in Tasmanian caves are very much more restricted, resulting in small and scattered populations of those animals dependent on the cave food supply.

Almost all Tasmanian caves are found in the western half of the Island where rainfall is high and caves carry active streams which are frequently subject to flooding. While floods may bring considerable amounts of organic matter into caves - especially inflow caves - they must also be destructive to terrestrial cave life.

Tasmania was much more affected than the Australian mainland by the

Pleistocene glaciations. At least two small ice caps occurred in western Tasmania and cirque and valley glaciers were widespread. Periglacial activity is known to have occurred down to 1,500 feet and recent work suggests that it may have extended down to sea level. Moore (1964) has suggested a close link between the occurrence of troglobitic beetles in New Zealand and the extent of Pleistocene glaciation, and thought that they were probably relicts of cold-adapted hygrophiles of an early Pleistocene glacial epoch. It is probably no coincidence that the only known Australian troglobitic beetle genus is Idacarabus Lea from south-eastern Tasmania.

Geology and Nature of Caves

The two major groups of rocks in which Tasmanian caves are developed are the Pre-Cambrian dolomites and limestones and the Gordon Limestone of Ordovician age. The latter is by far the most important cave-forming rock, and accounts for more than 90 percent of known Tasmanian caves. Permian limestones are found in the eastern half of the State, but no significant cave development has taken place. Caves on Flinders Island occur in Tertiary limestones and Pleistocene (?) aeolianite. Figure 1 shows the principal areas in which caves are known to occur and the rock type in which they are developed.

Outcrops of Pre-Cambrian dolomites and limestones are scattered throughout the western half of the Island. Due to the complex structure and stratigraphy of the Pre-Cambrian, it is not known whether all belong to a single horizon. The dolomites are usually light coloured and frequently show signs of silicification. A considerable thickness occurs at Hastings where some extensive caves have developed. The rock here is closely jointed. It is structurally weaker and less pure than the Ordovician limestones. Large amounts of impurities in the form of residual clays and sands have accumulated within the caves hampering downward development. Despite the high rainfall in this area, cave streams are intermittent and flow only after heavy rain. Apart from the Hastings caves a few small caves have been found in these rocks at Tim Shea, Jane River, Trowutta and Redpa; caves and potholes are also known to occur at Mount Roland Cross and Mount Anne, but have not yet been explored.

Ordovician limestone is widespread in western Tasmania and is assigned to a single formation - the Gordon Limestone - ranging in age from middle to upper Ordovician. The stratigraphic thickness of the limestone varies considerably, but reaches a maximum of the order of 5,000 feet in the Florentine Valley. It is a massive, dark grey rock which is impervious in bulk, with well-developed widely spaced joints. The limestone is strongly folded except in the far south of the State where dips are low. Most of it is of high purity containing over 90 percent of calcium carbonate. Some beds are very fossiliferous, while others contain few if any fossils.

The rock is very suitable for the development of large caverns. The

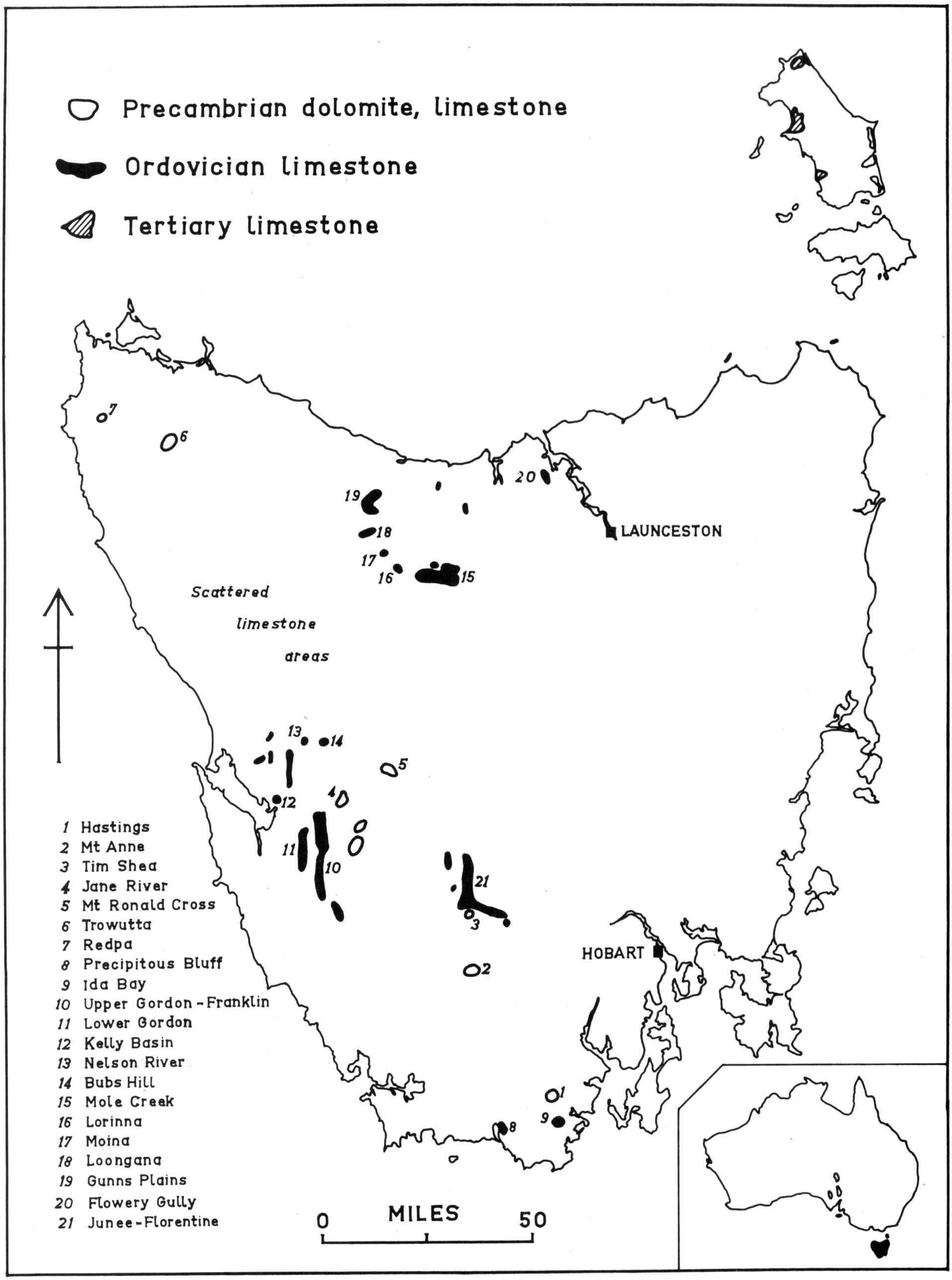


Figure 1. The distribution of karst regions in Tasmania with a key to the more important areas.

widely spaced jointing, combined with the impervious nature of the limestone, leads to concentration of water flow into a restricted number of channels at an early stage of cave development. Because of the high purity of the limestone, little residual material is released in contrast to caves developed in the Pre-Cambrian dolomites. The massive and thickly bedded character of much of the limestone makes it a very strong rock which is capable of supporting large caverns. Its occurrence in high rainfall areas with rain forest vegetation has meant that large quantities of acid water pass underground and cave development has been rapid. Caves show few if any true phreatic features. Fast moving water flowing in pressure tubes and free surface streams appear to have been mainly responsible for cave enlargement.

Conditions for solution of the limestone are so favourable, in fact, that in many areas limestone is found underlying broad river valleys and has little or no surface outcrop, except where it has been exposed only relatively recently, or where it is protected by some cover rock such as dolerite, basalt or Permian sediments. Most large cave systems are found in the latter situations.

Many caves occur in areas which have been affected by glacial outwash and/or periglacial activity. In both cases, large quantities of coarse non-limestone gravels have been fed into the caves and deposited. In many caves at Mole Creek, Florentine Valley and Ida Bay, remnants of cemented water worn gravels are found up to 40 feet above the level of present day underground streams.

The flat-lying Permian limestones in the eastern half of the State show almost no cave development because they are thin and interbedded with impervious shales and mudstones. They are also much less pure than their Ordovician counterparts. The main work on Tasmanian limestones is Hughes (1957).

Little is known about the character and extent of caves developed in Tertiary marine limestones and Pleistocene (?) aeolianite on Flinders Island.

Cave Fauna

The fauna in Tasmanian caves consists entirely of invertebrates. As previously mentioned, cave-inhabiting bats are absent and no evidence has been found that they were present in the past. Casual visitors to caves include lizards, snakes, brush-tailed possums and wombats, while some small caves have been used as lairs by the Tasmanian tiger, *Thylacinus cynocephalus* Harris. None of these vertebrates can be regarded as forming part of the true cave fauna. The better known cave invertebrates are now discussed in some detail.

Plate 1

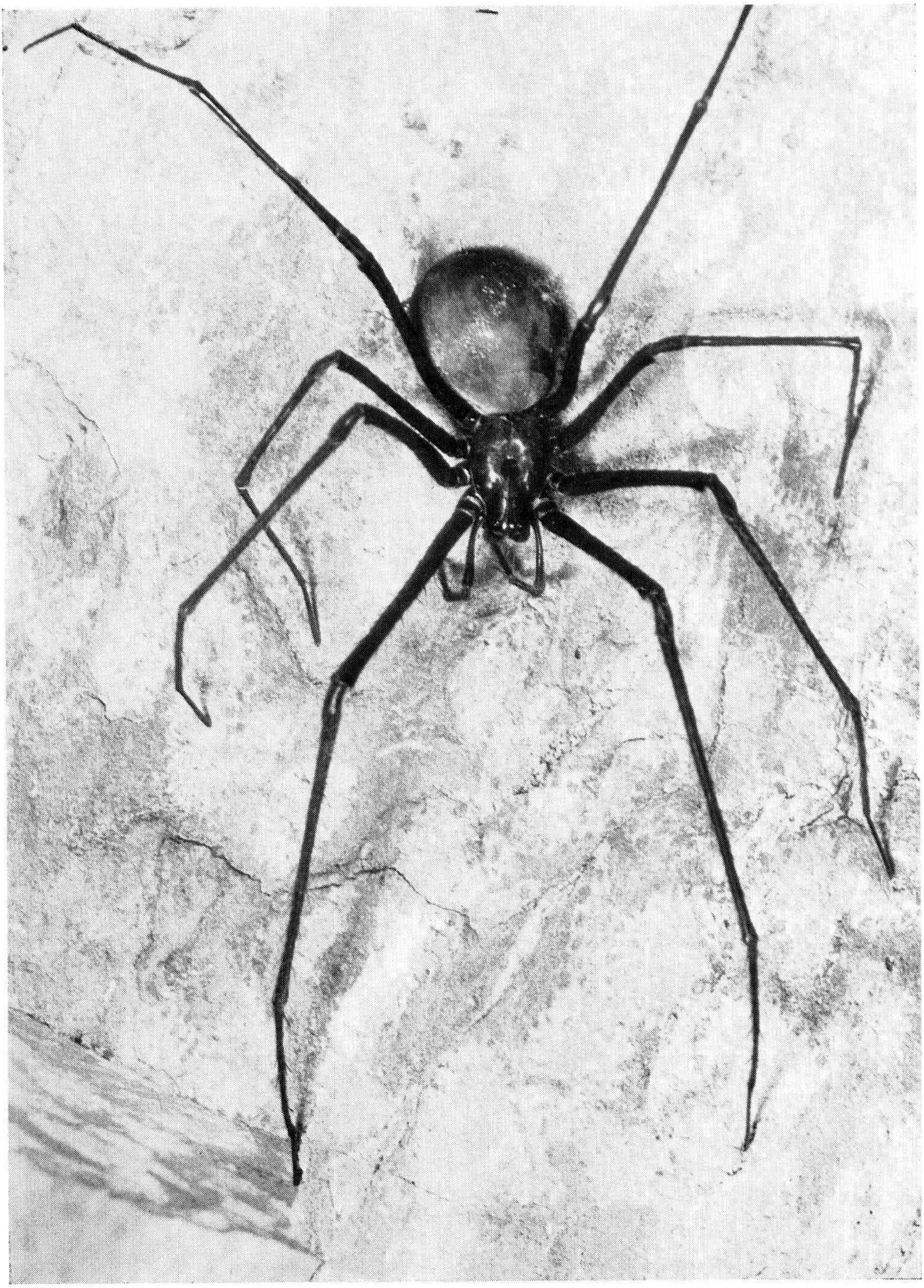


Photo: A. Healy

Female Tasmanian Cave Spider, *Hickmania troglodytes* (Higgins and Petterd), slightly larger than natural size. Cashion Creek Cave, Florentine Valley, Tasmania.

Spiders

The Tasmanian Cave Spider, Hickmania troglodytes (Higgins and Petterd), is an interesting troglophile which has received considerable attention in the literature. It is a member of a very small group of relict spiders, represented in four widely separated regions of the world - North America, China, Chile and Tasmania. It is distributed widely within the Island and is found not only in caves, but also in mine shafts, wells and hollow logs. Indeed, any cool dark cavity of sufficient size may serve as a suitable habitat (Hickman, 1963). Figure 2a shows localities known to the author where the Cave Spider has been recorded.

The spider was first recorded by Higgins and Petterd (1884) from a small cave in the Mole Creek district. They described it under the name of Theridion troglodytes. A more detailed description was given by Rainbow (1904) under the name of Ectatostica troglodytes. Hickman (1928) published further notes concerning its distribution, web and a description of the male. The family Hypochilidae to which the Cave Spider belongs was revised recently by Gertsch (1958). He regarded the spider as the type species of a new genus and renamed it Hickmania troglodytes.

The Cave Spider when fully grown has a leg spread of up to seven inches (Plate 1). It is frequently observed in caves, usually in the twilight zone, but may be found in total darkness. It never occurs far from a cave entrance. The spider's web is described by Hickman (1928) who observed: "The web of this spider always takes the form of a horizontal sheet, which under favourable conditions may attain relatively large proportions. In a small cave at Mole Creek a web was found suspended between the two walls of the cave, and it measured four feet long by nearly two feet wide. One end of the sheet led into a dark recess occupied by the spider. The threads, which form the framework of the web, are smooth, but the meshes are composed of a hackled band...It consists of two smooth parallel threads supporting a band of viscid silk." When undisturbed the spider usually hangs motionless in its web, but as soon as it becomes alarmed it makes a rapid retreat to a rock crevice.

The egg-sac is also frequently found in caves. It is pear-shaped, composed of white silk and is usually suspended from the roof or walls by a rather slender thread of variable length. An egg-sac was first described by Higgins and Petterd (1884) who found that it "was about the size of a pigeon's egg, and contained a large number of young, as well as many unhatched eggs, (and) was formed of a white crystalline web, which scintillated when the light was placed near it, producing a strikingly beautiful effect." During the period of incubation the female protects the egg-sac by surrounding it with its legs.

The Cave Spider resembles the trap-door and funnel web spiders in having two pairs of lung books, but differs from them in that the chelicerae are diaxial.

Other species of spiders have recently been found, but are not yet identified. Small spiders occurring in the vicinity of glow-worms, Arachnocampa (Arachnocampa) tasmaniensis Ferguson, have been collected - one from Mystery Creek Cave (Entrance Cave), Ida Bay, and two from Marakoopa Cave, Mole Creek. Two rather larger species have also been observed. One, grey in colour, has been found in Cashion Creek Cave, Florentine Valley, where it apparently lives in close association with glow-worms, but only one specimen has been collected. Another species was recently discovered in Little Trimmer Cave, Mole Creek, and three specimens have been collected. It is pale brown in colour.

Harvestmen

Only one species of opilion has been described so far from Tasmanian caves (Hickman, 1958). The type specimens of Monoxyomma cavaticum Hickman were collected from the Ida Bay Caves (almost certainly Mystery Creek Cave) in November, 1939, and consisted of four adult males, three adult females and six immature specimens. The harvestman is found in complete darkness, and invariably occurs in close association with glow-worms. It seems very likely that glow-worms are its main food supply, although it has not actually been observed feeding on them. (Related species are known to prey on New Zealand glow-worms (Richards, 1960).) The species appears to be quite common in Mystery Creek Cave, Ida Bay. The writer collected two specimens in December, 1964; three more were found in October, 1965; while in November, 1966, seven specimens were collected and several others observed (Plate 2).

M. cavaticum was known only from Mystery Creek Cave, but in the first three months of 1967 several specimens were observed and one collected from Exit Cave, also located in the Ida Bay area. The identification of this specimen was confirmed by Richards (pers. comm.).

Beetles

Until recently our knowledge of cave-inhabiting beetles in Tasmania was contained in a paper by Lea (1910). He described four species of beetles, one from Scotts Cave in the Mole Creek district, and three from caves at Ida Bay. The species from Scotts Cave was described by Lea as Cryptophagus troglodytes Lea belonging to the Crytophagidae. The description was based on seven specimens reputedly collected a long way from the entrance to the cave.

Of the three species described from Ida Bay, Lea considered that one belonged to the Dascillidae, and the other two to the Carabidae, subfamily Merizodinae. The dascillid was described as Cyphon doctus Lea. He stated that "it is almost certainly not a true cave inhabitant, although it was taken in such numbers as to preclude the idea of its being there by accident." No further specimens of this species have been col-

Plate 2

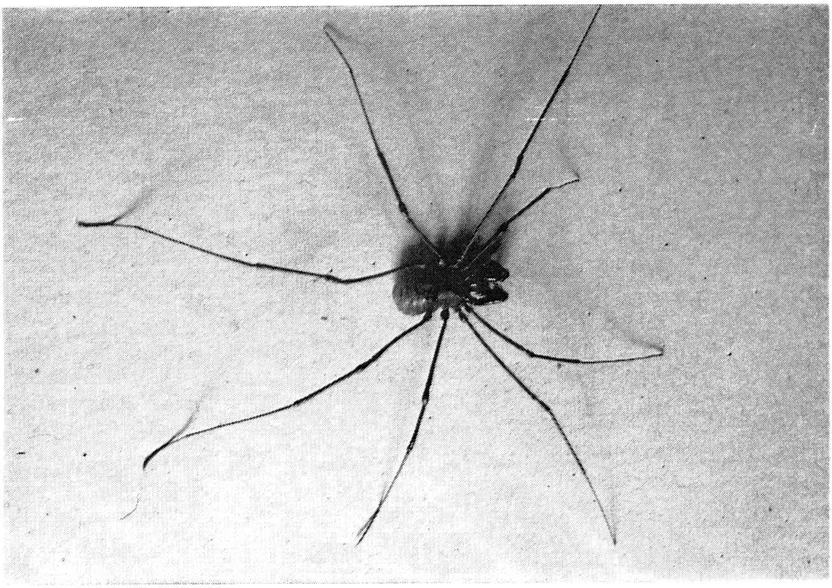


Photo: J. Gallagher (U.N.S.W.)

(a) *Monoxyomma cavaticum* Hickman. Mystery Creek Cave, Ida Bay, Tasmania.

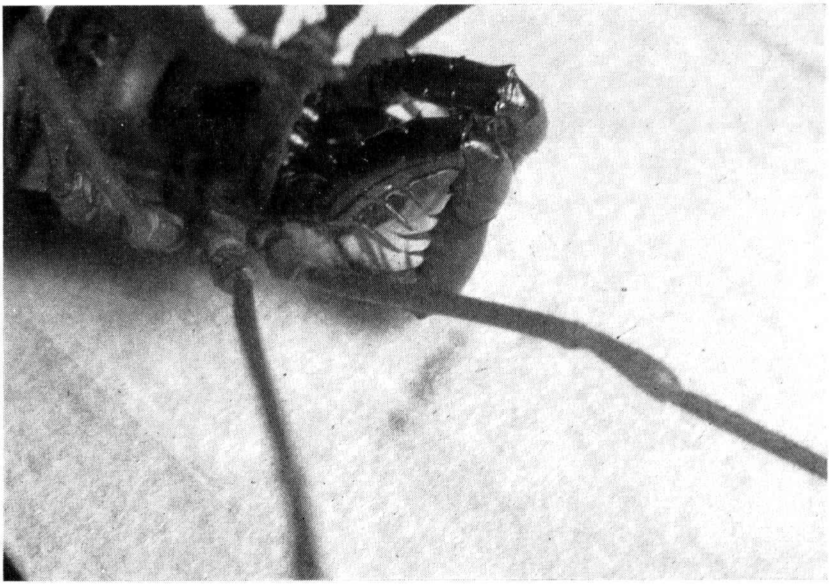


Photo: J. Gallagher (U.N.S.W.)

(b) Anterior portion of body of *M. Cavaticum* showing eye mound and large, powerful pedipalps.

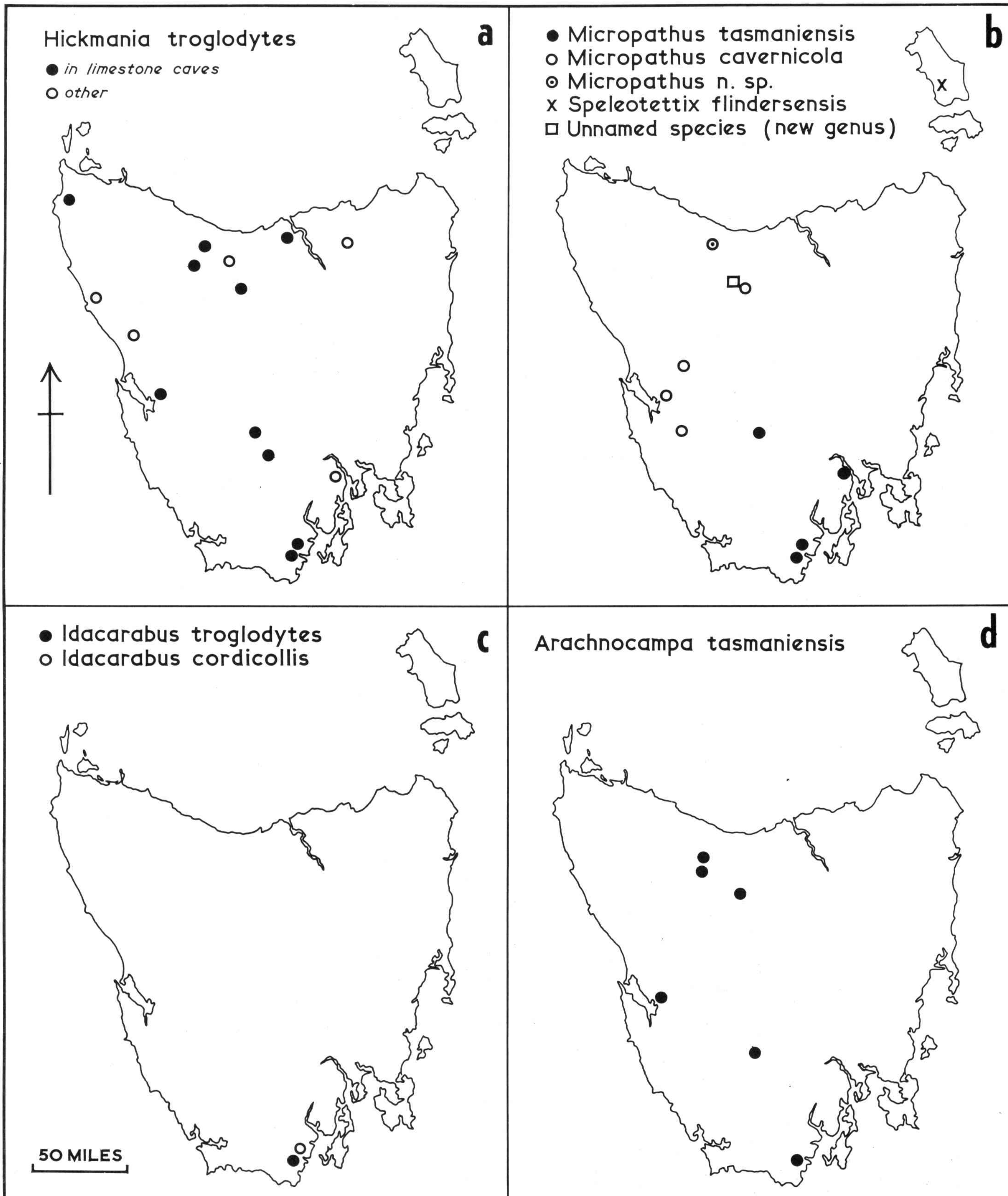


Figure 2. The distribution of some species of Tasmanian cave fauna. (a) Tasmanian Cave Spider, Hickmania troglodytes (Higgins and Petterd). (b) Species of cave crickets belonging to the Rhaphidophoridae. (c) Species of beetle belonging to the genus Idacarabus Lea. (d) Tasmanian glow-worm, Arachnocampa (Arachnocampa) tasmaniensis Ferguson.

lected from this area. The Carabidae were placed in a new genus Idacarabus Lea, and described as I. troglodytes Lea and I. flavipes Lea. Both species were regarded as true cave beetles.

I. flavipes was based on a single female specimen. This specimen has recently been re-examined by Moore (1967) who found that it belonged to the closely allied sub-family Trechinae and so must be removed from the genus Idacarabus. He considered that it was mainly an epigean insect whose presence in the Ida Bay Caves appeared to be due to occasional flooding.

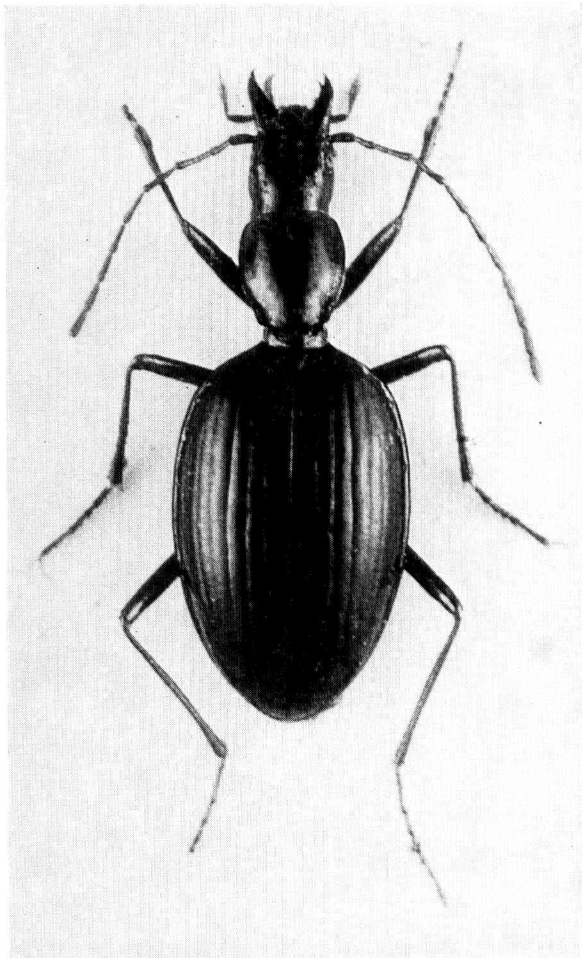
I. troglodytes on the other hand is a true troglobite. It was described by Lea from seven specimens, all of which were collected in the vicinity of glow-worms which he considered to form the main food supply. According to Moore (1964) features which make the species cave-adapted are degenerate eyes, vestigial wings, relatively long appendages, and the presence of a few sensory setae. A drawing of a male specimen is found in Lea's article, while Moore (1964) published a photograph which is reproduced here (Plate 3a), as well as a drawing of the same species. Moore briefly discussed its significance as a pointer to past climatic change.

In 1947, a single specimen of I. troglodytes was collected from Mystery Creek Cave, Ida Bay, by members of the Tasmanian Caverneering Club. In February, 1957, P.J. Darlington and his son twice visited the cave to collect Idacarabus. They found nothing on the first occasion, but on their second visit collected eight specimens crawling on the walls of a chamber not far from the entrance (Darlington, pers. comm.). In the past few years several unsuccessful attempts have been made including some by the author, to collect more specimens. Finally, in November, 1966, A.M. Richards and the writer collected several beetles and beetle remains from a sand and gravel floor in the same cave. The collection included remains of Idacarabus as well as a living tenebrionid, identified by Moore (pers. comm.) as Licinoma sp., belonging to the sub-family Adeliinae (Plate 3b). This is a particularly interesting find as it is the first record of the subfamily from Tasmania.

In June, 1967, a specimen of Idacarabus was collected from Exit Cave, Ida Bay, by the author. This is suspected to be I. troglodytes, but this has not yet been confirmed. If so, it would be the first record outside Mystery Creek Cave.

Moore (1967) has recently described the new species I. cordicollis Moore from six specimens collected by E. Hamilton-Smith in Newdegate and King George V Caves, Hastings, in 1963. This new species is apparently somewhat less cave-adapted than I. troglodytes since the eyes are larger, the appendages shorter and the overall build more compact. There are also other specific differences (Moore, pers. comm.).

The fact that different species of Idacarabus occur in Hastings and

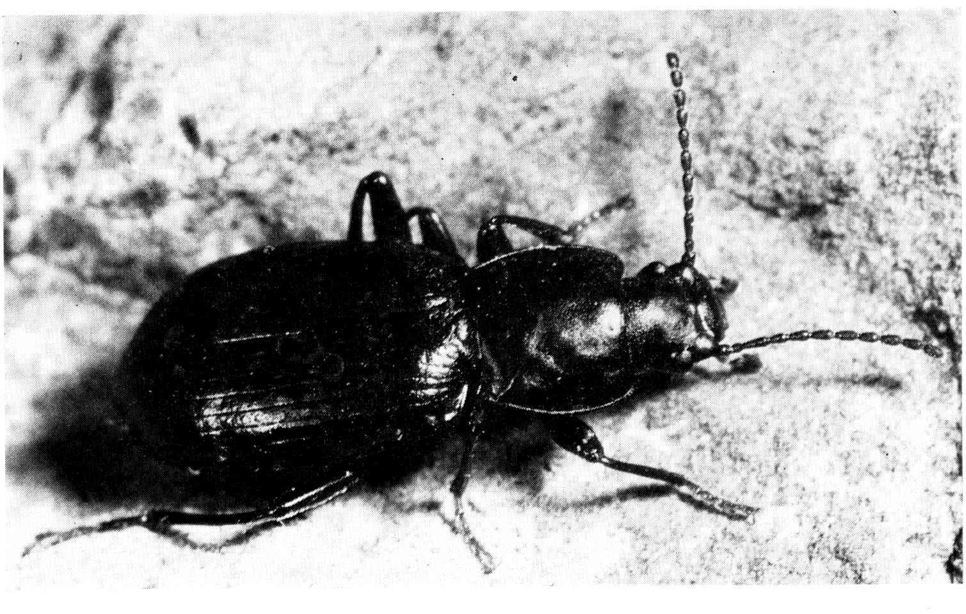


(a) *Idacarabus troglodytes* Lea. Mystery Creek Cave, Ida Bay, Tasmania.

Photo: C. N. Lourandos (C.S.I.R.O.)

(b) *Licinoma* sp. Mystery Creek Cave, Ida Bay, Tasmania.

Photo: A. Healy



Ida Bay (see Figure 2c) is of particular interest since the two areas are only a few miles apart. However, they are in different geological formations and are separated from each other by the Lune River and its floodplain.

Cave Crickets

Two species of cave crickets belonging to the family Rhaphidophoridae have been described from Tasmania and a third from Flinders Island. In the past 12 months, however, two new species have been collected and described (Richards, in press). As early as 1910, Lea mentioned the occurrence of two species in Tasmania, one at Mole Creek and another at Ida Bay, but they have been described only recently by Richards (1964a). Micropathus cavernicola Richards was recorded from Mole Creek and near the junction of the Franklin and Gordon Rivers, Western Tasmania, while Micropathus tasmaniensis Richards was described from caves in the Florentine Valley, Hastings and Ida Bay. It appeared that while M. tasmaniensis was found in south-eastern Tasmania, M. cavernicola occurred in the northern and western parts of the Island. This distribution has been confirmed through examination of additional material (Richards, in press). The author has collected further specimens of M. tasmaniensis from a dolerite fissure cave on Mount Arthur, Hobart, and additional specimens of M. cavernicola from Bubs Hill and near Kelly Basin.

Specimens collected from Gunns Plains in May, 1967, were found to belong to a new species of Micropathus (Richards, in press). The find was unexpected since the area is relatively close to Mole Creek. There are three limestone areas located in a discontinuous belt between Gunns Plains and Mole Creek which would appear to provide a suitable migration route for cave fauna. Collecting from the intermediate areas could perhaps help clarify the question. However, a brief collecting trip to Loongana failed to find any specimens. Since this limestone area is fairly extensive, and has numerous small caves, a further search may well be successful. No collecting has been carried out so far in the Moina and Lorinna districts.

In November, 1966, a new monotypic genus of cave cricket was discovered by A.M. Richards in a cave near Mole Creek. It is much smaller than Micropathus and, unlike the latter which usually occurs in large groups, all specimens collected so far have been solitary individuals. The new species shares its habitat with a large colony of M. cavernicola, but is found further inside the cave than the bulk of the Micropathus population. Following collecting trips by the author, enough specimens have now been collected for a description (Richards, in press). The species is known only from this cave and further collecting should not be carried out here as the population is sparse. It has not yet been searched for in other caves in the district.

The three species of Micropathus are commonly found in small caves away from underground streams prone to flooding. They are most common in the twilight zone, although it is not unusual to find them in total darkness. Solitary specimens of M. tasmaniensis are occasionally found a considerable distance from known entrances.

The species from Flinders Island was described by Chopard (1944) as Speleotettix flindersensis. It appears to be more closely related to species found in southern New South Wales and eastern Victoria than to Tasmanian rhaphidophorids (Richards, pers. comm.).

The distribution of the five species of Rhaphidophoridae is shown on Figure 2b.

Glow-Worms

The luminous larvae of a mycetophilid fly, Arachnocampa (Arachnocampa) tasmaniensis Ferguson, known as glow-worms, are found in a considerable number of Tasmanian caves. Each larva produces a number of sticky threads attached to a nest which is suspended from the roof and walls of the cave. The threads entangle prey such as small midges and moths. The larvae are almost invariably found on those portions of the roof and walls overhanging streams. However, they are not confined to caves, but have been observed also in rain forest and abandoned mines. They have been recorded from the following caves:

Ida Bay: Mystery Creek Cave* (Entrance Cave), Exit Cave*.

Florentine Valley and Junee Area: Cashion Creek Cave*, Growling Swallet and Junee Cave.

Mole Creek: Marakoopa Cave*, Wet Cave, Lynds Cave, Westmoreland Cave.

Gunns Plains: Gunns Plains Tourist Cave*.

Loongana: Old tourist cave.

Kelly Basin: Small unnamed cave.

In caves marked with an asterisk (*) they occur in large numbers. Displays in the Ida Bay caves, when at their best, are said to rival those of the Waitomo Caves, New Zealand. The location of limestone areas with caves containing glow-worm populations is shown on Figure 2d.

Since glow-worms are relatively rare in the bush, it was thought possible that distinct species or sub-species might occur in different parts of the State. However, specimens recently collected from Marakoopa Cave, Mole Creek, have been compared by D.H. Colless with specimens from southern Tasmania. No differences could be detected (Richards, pers. comm.).

The genus Arachnocampa Edwards has recently been re-examined by

Harrison (1966), who on the basis of wing venation has divided it into two subgenera : Arachnocampa Edwards to which the Tasmanian and New Zealand species belong, and Campara Harrison in which he placed two newly described species from eastern Australia. It is of interest to note that the Tasmanian species is more closely related to the New Zealand form than to species found on the mainland of Australia.

Cave populations of glow-worms show marked fluctuations which have not been studied in Tasmania. However, Richards (1960, 1964b) has made a detailed study of the New Zealand glow-worm, *Arachnocampa luminosa* (Skuse). Her main study area was the Glow-Worm Grotto of Waitomo Cave. She found that glow-worm larvae fed mainly on midges which bred in the mudbanks of the underground stream. The stream periodically became silted up and pumping was used to remove the mud. Richards found that its removal had a marked effect on the glow-worm population because it considerably reduced their food supply. She also found that winter floods could be destructive by washing away those larvae which had established themselves close to stream level during a dry period.

In Tasmania, the last factor is especially important in Exit Cave where sudden floods may occur at any time of the year and the creek may rise as much as ten feet above its normal summer level. Other glow-worm caves are also subject to flooding, but not to the same extent.

Several species of midges as well as caddis flies have been observed caught in the fishing lines of the Tasmanian glow-worm larvae, and occur in sufficiently large numbers to form an adequate food supply.

Some interesting historical accounts of the occurrence of glow-worms in Tasmanian caves can be found. Johnston (1888) in his *Geology of Tasmania* gives details of a visit in 1871 to the caves at Ilfacombe (now Flowery Gully) near Beaconsfield and states that "the extinction of the candlelights, or their concealment under a ledge of the stalagmitic floor discloses the pale blue glow-worms in clusters along roofs and walls..." Glow-worms are not found in the Flowery Gully caves at the present time, nor is there a permanent underground stream in the system. Yet, elsewhere, glow-worms are invariably associated with permanent cave streams. Maybe extensive land clearing in the district has converted what was once a permanent stream into an intermittent one, or possibly Johnston visited the caves after a series of unusually wet years.

An account of glow-worms in the Ida Bay caves entitled "The Glow-Worm Caves of Tasmania," was given by an unknown author in the *Scientific American* on November 23, 1895. He stated that "on the lights carried by the party being extinguished, the ceiling and sides of the cave seemed to be studded with diamonds - an effect due to millions of glow-worms hanging to the sides of the walls and from the ceilings....The only living creatures seen were the glow-worms."

Other Terrestrial Cave Life

Millipedes are another group of animals occurring in Tasmanian caves. Several specimens have been collected from Cashion Creek Cave, Florentine Valley, all of which appeared to belong to a single species. None were found far from surface entrances and they may have been chance visitors. Millipedes have also been found in Little Trimmer Cave, Mole Creek.

The most interesting find to date has been a millipede found crawling on a flowstone floor covered with some mondmilch in Exit Cave, Ida Bay. The passage where it was collected was approximately one third of a mile from the mouth of the cave, which is the only known entrance. In recent months, cave explorers have found two colonies of millipedes in the same cave. Both localities were a considerable distance from the entrance. No specimens have been collected.

All millipedes collected so far are being examined by P.M. Johns, who states (pers. comm.) that all species are undescribed, but that the most common genus has forest dwelling species.

A species of terrestrial isopod, Echinodillo cavaticus (Oniscoidea, Armadillidae), was described by Green (1963) from a limestone cave near Whitemark, Flinders Island. It was described from ten males and 13 females. No mention is made of any modifications or adaptations to cave life or the conditions under which it was found.

Small flies, midges, crane flies, caddis flies and stone flies have been found in several caves, sometimes in considerable numbers. Three species of crane flies have been collected, and have been identified by N.V. Dobrotworsky as Monophilus sp., from Marakoopa Cave, Mole Creek; Limnophila sp. from Cashion Creek Cave, Florentine Valley, and Mystery Creek Cave, Ida Bay; and Trichocera sp. from Cashion Creek Cave (Richards, pers. comm.). A stone fly, collected in the twilight zone of Growling Swallet, Florentine Valley, has been identified as Eusthenia spectabilis. It is very unlikely that any of these species are true cave dwellers.

Recent additions to the list of known terrestrial cave fauna have been made by Richards (pers. comm.) who found several gastropods as well as a single specimen of an amphipod in Little Trimmer Cave, Mole Creek. They have not yet been identified.

Aquatic Cave Life

Very little is known of aquatic cave life in Tasmania. Cave explorers and divers have reported on a number of occasions the presence of white or colourless "shrimps" in underground streams, but almost no collecting has been carried out. Williams (1965) recently recorded Anaspides tasmaniae (Thomson) from two caves in the Mole Creek district (Marakoopa Cave and an unnamed cave near Sassafras). It was found that the subterranean specimens differed from surface forms of the same species only in the smaller amount of pigment present. A specimen of the same species was found by Scott (1960) in the stomach of a very pale, feebly pigmented specimen of the introduced trout, Salmo fario, which had been caught in 1958 in the subterranean River Alph, Kubla Khan Cave, Mole Creek. Specimens of Anaspides species have also been observed on several occasions in Newdegate Cave, Hastings, and Exit Cave, Ida Bay. Anaspides tasmaniae and two related Tasmanian species, Paranaspides lacustris Smith and Micraspides calmani Nicholls are "living fossils" belonging to the order Syncarida. This order was widely distributed in Palaeozoic times but today is almost restricted to Tasmania (Nicholls, 1947). It is distinctly possible that further collecting will bring to light syncarida adapted to a subterranean environment.

The only other crustacea recorded from underground streams are amphipods belonging to the family Gammaridae. Some specimens were collected in 1947 by the Tasmanian Caverneering Club from Mystery Creek Cave, Ida Bay, and examined by Hickman who informed the T.C.C. that they resembled epigean species.

Recently, the author collected specimens from a small stream in Little Trimmer Cave, Mole Creek, where considerable numbers occurred extending from the twilight zone into complete darkness. They were looked at by W.D. Williams who found (pers. comm.) that they belonged to the Gammaridae. He stated that similar specimens had been collected from the Mole Creek area about 50 years ago and that the presence of eyes made it very doubtful that the species was truly cavernicolous. It is not known whether the specimens from Mystery Creek Cave belong to the same species as those collected from Little Trimmer Cave.

Discussion

Much more collecting is required to give an adequate picture of both the character and distribution of Tasmanian cave fauna, but some outstanding features are already emerging.

The genus Idacarabus contains the only troglobites found in Tasmania. They appear to be relatively rare in occurrence as one might expect with the limited food supply available in Tasmanian caves. There is no obvious reason why they should be restricted to the southeast of the Island and similar species may, in time, turn up in other limestone areas. As yet nothing definite is known of their food habits, while their life history is completely unknown. No larvae have been found.

Glow-worms are another interesting part of the cave fauna and up to date have received relatively little attention, at least compared with their New Zealand counterparts. Although not restricted to caves, they appear to be relatively rare in the bush unlike the New Zealand species.

The Tasmanian Cave Spider, a typical troglophile, derives its interest from the fact that it is a member of a very small group of relict spiders. Although not confined to caves, the twilight and transitional zones appear to be their stronghold, and this habitat may have ensured their survival during the rapidly fluctuating climatic conditions of the Pleistocene.

The three species of Micropathus recorded from Tasmania show an interesting distribution pattern. M. cavernicola and M. tasmaniensis may have developed as different species when the two distribution areas were isolated from each other by glaciation during the cold periods of the Pleistocene. In the last glaciation small ice caps occupied the Central Plateau and an area to the west, while extensive valley and cirque glaciation occurred further south. The occurrence of a distinct species of Micropathus at Gunns Plains is less easily explained.

The aquatic cave fauna is very poorly known and, in contrast to the Australian mainland, has not so far yielded any troglobitic species.

Acknowledgments

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The distribution maps of Figure 2 were drawn by Mr. G. van de Geer, Geography Department, University of Tasmania, Hobart.

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A B S T R A C T

NEW AUSTRALIAN CAVE CARABIDAE (COLEOPTERA). By B.P. Moore. Proc. Linn. Soc. N.S.W., 91 (3), 1967 : 179 - 184.

Three new species of cave-dwelling Carabidae are described belonging to three different subfamilies. Idacarabus cordicollis (Merizodinae) is recorded from Newdegate Cave and King George V Cave, near Hastings, Tasmania. It is less obviously cave-adapted than I. troglodytes Lea. Thenarotes speluncarius (Harpalinae) has been collected from Abrakurrie Cave, Buckalowie Cave and Cave Number 11, Nullarbor Plain. The species is provisionally placed in Thenarotes pending a revision of the Australian Harpalinae. Anomotarus subterraneus (Lebiinae) is known from Riverton Cave, South Queensland. It is the first cavernicolous member of the genus, and provides an evolutionary link between the epigean lebiines and the exclusively cavernicolous species of Speotarus. It shows no signs of cave adaptation. - A.M.R.

R E V I E W

MULLAMULLANG CAVE EXPEDITIONS, 1966. Ed. A.L. Hill. Cave Exploration Group (South Australia), Occ. Pap. No. 4, 1966 : 48 pp., text figures 13, folding maps 5, photographs 24.

This publication is not simply an excellent dollar's worth of offset lithography; it can fairly be said to be a milestone in the history of Australian caving. Good speleological work has often been done in our caves, but almost equally often the results have never been published, or only published belatedly. Sparked by the thought that Mullamullang in the Nullarbor Plain was likely to prove Australia's largest cave - by volume and by length - as a result of prompt publication by the Sydney University Speleological Society 1963-4 Nullarbor Expedition (Anderson, Helictite, 2 (4) : 121 - 134, 1964) and of brief reports by later Western Australian Speleological Group and other parties, the Cave Exploration Group (South Australia) organised no fewer than three expeditions in 1966. They discovered more than two miles of unknown crawlway, and published much of the results in this Occasional Paper within the year. All concerned deserve great credit for their parts in this; on one of them will, I am sure, object to the drive and organising capacity of Alan Hill being specially recognised.

After short accounts of the location of the cave and the history of its exploration, the logistics of the 1966 expeditions are dealt with at some length. The most ambitious underground camping in the brief history of Australian caving societies - 14 spent a week, 12 spent three days at a camp 2½ miles in - warrants this detailed account. Much can be learned from it, but perhaps the most surprising point is that the amount of fresh water to be carried in was reduced substantially by the underground party managing to drink, without ill effects, the cave water with eight parts salt per thousand after breaking themselves in on a half and half mixture.

A technical section follows. The cave survey methods are clearly described and the results admirably drawn out, though for economy they are presented on a number of separate folders. Many readers will be enticed, as the reviewer has been, to cut them up and reconstitute plan and section as a whole to admire and comprehend. A theodolite and steel band traverse was carried through the main passage, checking Anderson's framework for the first 1½ miles, for which the 1963-4 detail was incorporated in the new map. Beyond the S.U.S.S. survey, detail was added to the theodolite traverse by miner's dial and 100 feet tape or two feet stadia staff. Stadia measurements were extremely useful over Mullamullang's underground mountains of loose rock. To put the heights on an absolute basis aneroid traverses were run to the sea.

Next the communications system and the job of installing it are set out in useful detail. The system worked well though there was a lack of suitable transceivers for the surface parties working as much as 50 miles from base camp.

In the section on photography, the most interesting matter relates to the Crowle and the Hill modifications in the directions of lightness and ease of manufacture to the Fairlie-Cuninghame version of the "Diprotodon" or flash powder gun. Hill also devised an exposure calculator to save the operator from going crazy when many others "ride" his flash and his patience. The many half-tone illustrations show that a lot of photography was carried out, though the only moderate quality of the reproduction may not have done it justice.

The scientific section comes last, appropriately since these results would not materialise but for the efficiency of the other aspects of the expeditions. A stratigraphic note by D.C. Lowry brings out the important point that the cave may be mainly developed in Tates' yellow bryozoal calcarenite of probable Oligocene or Lower Miocene age, a formation only a few feet thick and speleologically unimportant over the South Australian border. T.M. Wigley records an artificially struck chalcedonic flake from halfway down the entrance rockpile.

In a biospeleological note, E. Hamilton-Smith reports on the "Nullarbor Plain Cockroach", a troglodytic undescribed species; Brises acutiformis, a beetle usually living on the surface; and the two bats found in the cave, only one of which, Chalinolobus morio, is known to roost in Nullarbor caves.

Hill and W.H. Rouse record some water analyses, the low carbonate content amongst the anions being the most noteworthy aspect. Wigley and Hill then discuss the cave decorations, which are more elaborate than in other Nullarbor caves. Especially surprising is their mineral variety; the infrequent carbonate decorations appear to be aragonitic rather than calcitic whilst the most common are gypsum encrustations, flowers and needles, found near the water bodies and up in the Ezam Extension. Wirelike decorations in the Ezam and the Easter Extension were found to be of sodium chloride, a mineral not thought to have been recorded previously in cave decorations. These rocksalt decorations are attributed to seepage water directly from the surface above, not to groundwater. Mention is made of the Clam, a large flake of rock being wedged upwards against gravity by salt-wedging.

Finally, but by no means least, comes the account of the meteorological observations by Wigley, I.D. Wood and M. Smith, the most solid effort in cave meteorology so far in Australia. After reviewing the possible causes of breathing in such a cave as Mullamullang, they set up the hypothesis that the oscillations in air movement are due to changes in atmospheric pressure and that pore spaces in the limestone form part of the system as well as the penetrable cave space. On this basis it is possible to calculate that the air movements will change about eight hours after the diurnal change in atmospheric pressure and that the wind will change round simultaneously throughout the cave. Observations at three widely spaced underground stations, the farthest 2 1/4 miles in, show that these conditions are fulfilled, though intense depressions upset the rhythm. Though these successful predictions justify regarding atmospheric pressure changes as the cause of breathing, this reviewer thinks it doubtful whether the tiny pores of the bedrock contribute significantly to the cave circulation, though small solution tubes could do so easily. The authors also devise a method of calculating from air movements at different stations whether there is unknown cave between the two points; application of this to Mullamullang was inconclusive because it was possible that air bypassed one of the measuring points through the interstices of a rock pile. Greater diurnal temperature variations than would be expected were recorded in Mullamullang and these were attributed to the well developed air movements.

In the introduction, it is claimed with justice that Mullamullang, because of its greater size and complexity than other deep caves, "could hold the key to the geomorphology of the Nullarbor." Regrettably, no account of the geomorphology was included in this report, possibly because time is needed to assess properly its far-reaching implications. The cave survey provides grist to the geomorphologist in no mean measure, of course, and there are incidental geomorphological comments here and there in the book. Not all are well-conceived, as for instance the suggestions that the cave winds had produced ceiling sculpture in the bedrock by abrasion and that the Dome is due to aeolian deposition. So reports from those expedition members concerned with the geomorphological side more specifically will be awaited with much interest. Despite this lack, Australian cavers can look with some pride on this concrete evidence of the growing maturity of speleology in this country. - J.N. Jennings.

A B S T R A C T S

THE RHAPHIDOPHORIDAE (ORTHOPTERA) OF AUSTRALIA. 4. A NEW GENUS FROM SOUTH AUSTRALIA. By Aola M. Richards. Proc. Linn. Soc. N.S.W., 91 (2), 1966 : 109 - 113.

A new genus *Novotettix* Richards is recorded from limestone caves at Naracoorte, south-eastern South Australia. The new species *N. naracoortensis* Richards has been collected from Alexandra Cave and Victoria Cave on the South Australian Tourist Bureau Reserve. It has also been taken from Haystall Cave, Corner Fence Cave and Smoke Cave at Joanna, about four miles from the Tourist Reserve. The unusually large colony by Australian standards, of over 1,500 cave crickets in Alexandra Cave, may be accounted for by the absence of predators such as bats and rats. This is one of the larger Australian Rhaphidophorids. Sexual dimorphism is strongly developed. It does not show any close affinities with other known Australian cave crickets.

ETUDE CRISTALLOGRAPHIQUE DES EDIFICES STALACTITIQUES. By C. Andrieux. Bull. Soc. Franc. Miner. Crist., 85, 1962 : 67 - 76.

Andrieux classifies stalactites in three groups : solid (massive), monocrystalline, and polycrystalline. This study is limited to monocrystalline stalactites which occur in two quite distinct forms, tubiform and polyhedral, as exemplified by about 100 specimens collected from the recently discovered "Crebique" cave in the Dordogne region.

Tubiform stalactites have a single, good cleavage plane and a single plane of symmetry. Using a modified goniometer, in which the angles measured are referred to the direction of gravity, Andrieux has measured the angle between the cleavage plane and the axis of elongation of the stalactite. If each specimen is oriented to a set of reference axes, this data can be used to determine the crystallographic index of the axis of elongation, which coincides with the direction of gravity.

Andrieux has adopted the triaxial "Miller" method of notation, but it is unfortunate that he has chosen an orientation of the reference axes which is different to that usually employed by British workers. This results in a cyclic permutation of the index notation.

The 96 specimens measured comprise eight groups, each with a definite crystallographic orientation of the axis of elongation, corresponding to some favoured direction of the rhombohedral form. Consequently, it is demonstrated that the ternary axis of the rhombohedron does not coincide with the direction of gravity.

Polyhedral stalactites are much rarer. They are produced by a secondary, lacustrian growth stage of tubiform stalactites. As in the case of the tubiform type, the axis of elongation coincides with the direction of gravity. It always has the same crystallographic index $(10\bar{1}4)$, corresponding to a particular direction of the rhombohedral form. This leads to the conclusion that only tubiform stalactites with this particular orientation act as a nucleus for polyhedral stalactites. - E.G. Anderson.

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END OF VOLUME 5