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A. Clarke

Tasmanian Cave Spider

Helictite

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Helictite was founded by Edward A. Lane and Aola M. Richards in 1962. It is intended to be wide ranging in scope from the scientific study of caves and their contents, to the history of caves and cave areas and the technical aspects of cave study and exploration. The territory covered is Australasia – Australia, New Zealand, the near Pacific Islands, Papua New Guinea and surrounding areas, Indonesia and Borneo.

In 1974 the Speleological Research Council Limited agreed to support the Journal with financial assistance and in 1976 took over full responsibility for its production. From 1974 to 1997 the Journal was edited by Julia James assisted by other members of the Speleological Research Council Ltd. In 1998 the Speleological Research Council Ltd became the Speleological Research Council Inc.

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1. To publish the results of scientific studies in all fields of speleology in Helictite – Journal of Australasian Speleological Research and other publications.
2. To promote the exploration, surveying and scientific investigation and evaluation of caves and cave systems.

Speleological Research Council Inc.

Journal of Australasian Speleological Research

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Contents

Cover: Tasmanian Cave Spider (*Hickmania troglodytes*) straddling its web in a cave at Bubs Hill in western Tasmania - about 1.5 times life size. Known from Tasmanian caves since 1883, a number of specimens of this spider are in the cave fauna collections of the South Australian Museum.. *Photo by Arthur Clarke, Graphic design by Ken Grimes.*

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This issue is published in October, 2000

Editorial

Susan White and Ken Grimes.

The second issue of Volume 36 has taken some time to produce. The issue is dated for 2000 as determined by the current policy of each issue carrying the actual publication year.

Changes to the ownership of Helictite

There have been more changes to the structure of Helictite. In August 2000, the Speleological Research Council Inc. agreed to wind up and transfer it assets to the Australian Speleological Federation. The SRC was always a small organisation and had become smaller, which made production of Helictite and its other activities increasingly difficult. The ASF has undergone major changes over the last decade that make it a much stronger organisation with the potential to further the aims of the SRC. In practical terms there will be no immediate changes to Helictite. The present editors agreed to undertake the job for about 5 years and will continue until further notice.

Most of the copy for Volume 37(1) has been received. The abstracts of the very successful Wellington Karst Workshop in February 2000 will be included in that issue.

Volume 36 (2)

This issue contains papers on cave fauna holdings in the South Australian Museum and the dating of the calcareous dune ridges in southwestern Victoria. The South Australian Museum article in particular, has some interesting comments on the changes of practice in biological collecting and the lodgment in museum collections which have occurred over the past century.

Wanted:

- Local representatives in each Australian state and other countries, to promote Helictite locally and to assist in soliciting articles. Also people in major institutions who are prepared to send summaries of research in progress and other items for the "News and Views" section.
- Volunteers to join the editorial and production team.
- Authors! Cavers should not be shy. Look through our back issues, there have been many authors who were "informed speleologists" rather than professional scientists. If you are not associated with a major institution, we can assist with drafting of figures and formatting of photos and are happy to make preliminary comments on proposals for papers. See the Information for Contributors inside the back cover.

Clarke, A., 2000: Records of the Tasmanian cave fauna known or purported to be in the South Australian Museum. *Helictite* **36** (2), 23-37.

Records of the Tasmanian cave fauna known or purported to be in the South Australian Museum

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Abstract

The South Australian Museum collection of invertebrate species includes specimens recorded from Tasmanian caves since 1901. Most of the Museum's invertebrate collection is not compiled on any electronic database, but 67% of the Tasmanian cave species in the South Australian Museum collection are included in the "BS" index of cave invertebrates recorded by Hamilton-Smith and some additional specimens occur in other cave fauna collection records. Investigations of the specimen lodgments of invertebrates (including "type" species) collected from Tasmanian caves included a review of the descriptions in literature of cave fauna taxonomists and collector's records, plus a subsequent search in the South Australian Museum. Present research of lodgement records of Tasmanian cave fauna indicates that the South Australian Museum collection should contain at least 334 specimens, represented by 41 species from 9 karst areas and 23 caves in Tasmania, although the exact cave locations for some early collections have not been recorded. Fourteen species have not been identified and a number of museum lodgments have not been formally determined. Over 40% of the specimen lodgments, including 13 type species, purported to be in the collection were not sighted during the museum search. Some unsighted specimens are missing, possibly on loan, lodged in other collections or not actually lodged as inferred or indicated in the reference material.

Introduction:

From mid-1996 to 1997, the writer was engaged to compile a database of cave invertebrate species from Tasmanian caves for the Regional Forest Agreement (RFA) in Tasmania (Clarke, 1997a; 1997b). The compilation of Tasmanian cave fauna records was initially collated from the personal records of Clarke, Eberhard, Goede and Hamilton-Smith, plus a literature search through the reports of taxonomists and invertebrate specialists who had studied, collected or identified Tasmanian cave species. During compilation of the large database of 4700 occurrence records for 643 invertebrate species from 492 caves in Tasmania, the writer was made aware of the numerous cave fauna specimens that were held by various institutions in other Australian states, as well as some lodgments in overseas institutions.

The Australian institutions included several universities, government organisations such as the CSIRO in Canberra and its subsidiary body: Australian National Insect Collection (ANIC), plus most of the mainland Australian museums. For example, in recent decades, many spiders, harvestmen and hydrobiids (aquatic snails) from Tasmanian caves have been lodged by Clarke, Eberhard or Goede with the Australian Museum (Sydney), where the taxonomists: Mike Gray, Glenn Hunt and Winston Ponder have respectively identified these specimens. There is also a small collection of Tasmanian cave species at the South Australian Museum (SAM) in Adelaide, represented by specimens collected from Tasmanian caves since 1901. Many of these are lodgments that were recorded by Hamilton-Smith during his long association with SAM from the early 1950's. During the time Hamilton-Smith was associated with the museum, he compiled a "Biospeleological Collection", registering lodgments of cave fauna with a "BS" prefix, initially basing his system on the existing cave fauna specimens in SAM and his own collection records (Hamilton-Smith, 1962).

This paper is designed to serve several purposes:

- To augment the record of Tasmanian species collated during the compilation of the Tasmania RFA cave fauna database;
- To provide a published record of the recent research into the known or purported lodgments of Tasmanian cave fauna in SAM - based on the literature records, examination of BS cards and the on-site inspection at the museum;
- To demonstrate some of the historical factors influencing the lodgment of specimens in interstate institutions;
- To provide an indication of the problems associated with the large collections in institutions, the management and/or taxonomy of specimens and the reliance on taxonomist's records, especially where the lodgments do not match the records of taxonomists or collectors;

- To act as a reference source or starting point for further research by collectors, taxonomists, cave biologists, or other speleologists who are interested in the study of cave fauna, Tasmanian species or museum lodgments;
- To exemplify the range of cave invertebrate species held as lodgments in museums outside of the State where the specimens were collected;
- Lastly, to place on public record a list of the Tasmanian cave fauna specimens (including type species) known or purported to be at SAM.

The history of Tasmanian cave species in the South Australian Museum:

The lodgment of Tasmanian cave species in the South Australian Museum (SAM) dates back to the early 1900's, around the time when Arthur Lea was appointed as the Curator of Entomology at SAM, in 1911. Lea had been previously employed as the Government Entomologist in Tasmania (Musgrave, 1932), and while in Tasmania, he collected species from caves at Gunns Plains, Ida Bay and Mole Creek in 1901 and 1909 (Lea, 1910); some of these specimens were subsequently lodged in the South Australian Museum. There were additional lodgments of specimens collected from Tasmanian caves between 1909 and 1930: R.A. Black (who was probably collecting for Lea) collected seven cryptophagid cave beetles in *Scotts Cave* at Mole Creek in 1909; R.H. Pulleine collected Tasmanian Cave Spider specimens from an unknown cave at Mole Creek in 1924; glowworms collected from *Mystery Creek Cave* at Ida Bay in 1925 have been attributed to E.W. Ferguson; and Herbert Finlayson (who later became the Honorary Associate of Mammals at SAM) collected cave crickets from *Ranga Cave* on Flinders Island in 1930.

The subsequent lodgments of cave fauna in SAM largely emanate from the studies and collections undertaken by cave biologists (or biospeleologists) and invertebrate specialists, sometimes supplemented with material collected by recreational cavers. Over the last forty to fifty years, Goede and Hamilton-Smith, plus taxonomists such as Moore and Richards, have lodged numerous cave invertebrate specimens (including Tasmanian species) with SAM in Adelaide. The predominantly cavernicolous species recorded by Hamilton-Smith on his "BS" Card Index system, refer to specimens collected from caves (and mine adits) in many parts of Australia and sometimes overseas. A considerable number of the Tasmanian cave specimens lodged in SAM collections appear to have been in accord with these BS registrations by Hamilton-Smith. Hence it was assumed that most of the Tasmanian species with "BS" registrations were in fact lodged in SAM as indicated during the compilation of the RFA cave fauna database, which included 93 lodgment records for SAM - 80 of which had been accorded with BS card numbers.

Historical factors relating to lodgments in interstate institutions:

The early museum collections of invertebrate specimens in most states of Australia (including Tasmania) were largely the result of the donated or purchased collections received from amateur biologists, entomologists or naturalists. These donations or purchases were sometimes housed separately as individual private collections, rather than being organised as a total museum collection arranged in taxonomic order. Museums generally relied on these private sources of specimen supply until around World War I when the first entomologists or curators were appointed to museums (Musgrave, 1932). In earlier times, when it was commonplace for museums to purchase their specimens, sometimes from the personal collections of their employees or museum associates, museums subsequently employed their staff on fieldwork and expeditions to collect specimens within their own state or from selected areas interstate. This led to the South Australian Museum being considered as a repository of some eminence, because in addition to housing the many private collections - particularly of insect groups (Musgrave, 1932), it was pro-active in the late 1800's and early 1900's by promoting the collection of species from other regions of Australia and not being concerned with the constraints of state boundaries. In his detailed biographies of Australian curators, collectors and museum holdings, Musgrave records that the South Australian Museum had a wider range of insect collections than any other museum in Australia, as well as one of the largest collections of "type" specimens (Musgrave, 1932).

Historically, there has been a tendency to send specimens to those institutions that had a resident expert or taxonomist who specialised in a particular species group. Similarly, additional specimens of a particular species or species group were often collected for lodgment purposes in order to provide further reference material for specialist taxonomists to study and compare. As an adjunct to this, it was common practice amongst taxonomists to send identical specimens (paratypes or allotypes) or additional reference material, of recently described species, to interstate or overseas institutions. Specimens would be sent to those institutions considered as a recognised repository, due to:

- Their reputation for curatorial skills or cataloguing of lodgments;
- Where there was already a significant collection of a particular species group;
- Where there was a known interest or resident expert in the species group, or
- Simply as a reciprocal process for lodgment of new species.

It was a common practice for duplicate specimens of

new Australian species to be lodged with the ANIC at CSIRO, Canberra, Australian Museum in Sydney, South Australian Museum in Adelaide or the British Museum of Natural History in London.

The curators of some museums were often interested to obtain a wider geographic range of specimens to either enhance their collections for public inspection or to establish their site as a known repository for a particular species group. For example, during the recent search of the spirit collection of rhaphidophorid (cave cricket) specimens at SAM, it was apparent that specimens were derived from caves in many parts of Australasia (other than Tasmania). There are specimens from the (now drowned) Texas karst area (in southern Queensland); Buchan (Victoria); Tantanoola and Naracoorte, (southeastern South Australia); Nullarbor (Western Australia and South Australia), from other caves in Western Australia, Northern Territory and New Guinea. It is assumed that an even larger geographic range of cave crickets would have been lodged in the ANIC or Australian Museum, because these sites were the chief repositories used by Aola Richards for lodgment of type specimens for new rhaphidophorid species collected from caves or surface sites throughout Australia, New Zealand, New Guinea and the Pacific Islands. During visits to interstate or overseas locations, it was common practice for museum staff or taxonomists to collect a wide range of animal or plant species from a particular habitat site or a range of habitat localities, often extending beyond the biological group of their immediate interest.

The enormous museum collections such as those at SAM were generally organised as taxonomic collations arranged within the structural order of the different private collections, rather than as a part of the whole museum collection. Another historical trend that developed in some museums including SAM involved the collection of species from particular regions and environmental or ecological habitats. For example, there were comprehensive beetle collections from Hawaii, Tasmania and Queensland (Musgrave, 1932), along with the invertebrate collections from pasture or agricultural sites, from forests, different soil types, arid or desert zones, river or riverside areas and eventually during the time of Hamilton-Smith, specimens from caves (E. Hamilton-Smith, pers. comm.). The different styles of organising museum collections, collated on either the traditional taxonomic classification or the environmentally based structures, invariably led to some differences of opinion and tension between curators, their staff and other museums (E. Hamilton-Smith, pers. comm.).

The reputation of a museum being able to provide identifications was another factor that influenced the lodgment of specimens, e.g., for cave biologists often at relatively short notice. Although this can still occur today, it is now considered preferable to lodge and register all collected specimens in a museum or similar institution within the state where specimens are collected. Once registered, specimens can then be sent on loan to other institutions or specialists for comparative studies or identification and can be supplied as "voucher" specimens on long term "loan" to other institutions for teaching or display purposes.

A number of institutions are now establishing electronic (or digital) databases, particularly where the details of specimen collections had been previously recorded or registered on card indexes. In the instances where these electronic (digital) databases have been established, access to museum records and collections is simplified, provided that the name (and spelling) of the species, genus or family group, or the exact name of the collection site is known. Museums may however charge a service fee for providing this information.

Determination of cave fauna records at the South Australian Museum:

Although a number of museums have started to compile digital databases of their invertebrate collections, at the time of my initial enquiries during mid-1996, such a database had not been started at the South Australian Museum. Hamilton-Smith kindly gave permission to reference his BS Index Cards for Tasmanian species; most of these BS records were included in the Tasmanian RFA cave fauna database (Clarke, 1997a). Further enquiries with museum staff indicated the likelihood of additional Tasmanian cave species lodged at SAM by other collectors or taxonomists. Museum staff indicated that time constraints prevented them searching their massive collection: drawers or cabinets containing their glass slide-mounted specimens and more than 100,000 "wet" (bottled spirit) or "dry" (pinned) specimens. (Staff at SAM generally refer to these latter collections separately: as the "wet store" or "spirit" collection and the "dry" collection.) It was apparent that in order to establish a more accurate determination of Tasmanian cave fauna specimens at SAM (confirming the presence of recorded specimens and the existence of additional lodgments), that an actual search of museum holdings was required.

Prior to examination of the SAM collection and sighting of actual lodgments in the museum, further reference was made to the Hamilton-Smith BS index cards. Some additional or supplementary information on specimen lodgment was obtained from a variety of reference sources including the collection records and correspondence files of Tasmanian speleologists, such as Albert Goede, and the published reports of several taxonomists. For example, the published records and species descriptions of taxonomists such as Mike Gray, Glenn Hunt, Arthur Lea, Barry Moore and Aola Richards include reference to the lodgment of Tasmanian cave specimens in the South Australian Museum.

In September 1997, a brief search of invertebrate fauna at SAM was undertaken, concentrating on those

family groups of species known to occur in Tasmanian caves and locating the known species recorded on BS cards or in other references. The accessed specimens were located in either the spirit collection or the dry collection. Some specimens appeared to be missing altogether, so the loan records were also checked. The glass slide collection was not inspected.

The documentation details of the specimens were recorded where possible; some had very limited information accompanying them, but additional data was obtained by cross-reference to matching records listed in published reports or collectors' records. Some missing specimens may be located in other sections of the museum. The "type" specimens located (i.e., holotypes, paratypes or allotypes) were amongst the general collection with specimens of the same species.

The Tasmanian cave fauna collection:

The results of these above investigations, supplemented by further reference to the BS index cards and taxonomists reports, form the basis of the lodgment records listed in the distribution of invertebrate species from Tasmanian caves and karst areas (see Figure 1 and following sections). It is probable that there are additional Tasmanian cave specimens included in the SAM collection among the several sections and/or family groups that were not checked during the recent museum study. The invertebrate fauna lodgments in SAM include species collected from mine adits and caves in pseudo-karst (or non-karst) areas in Tasmania; these are excluded from this study of cave fauna records.

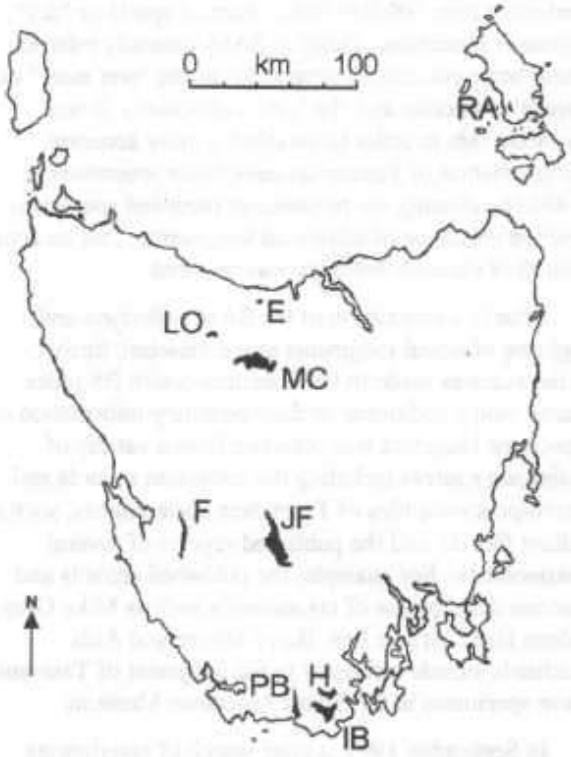

Figure 1: Location of areas referred to in text

The SAM collection is known or purported to include a total of 334 specimens (adults, juveniles, pupae or larvae) of 27 identified (and 14 unidentified) species, from 23 caves in nine karst areas: Eugenana, Franklin River, Hastings, Ida Bay, Junee-Florentine, Lorinna, Mole Creek, Precipitous Bluff and Ranga [see Figure 1].

Species list of Tasmanian cave invertebrates at the South Australian Museum:

The following data listing the 41 Tasmanian cave species is based on the lodgment records of species known or purported to be at SAM (see following section). As shown in this list below, fourteen of the species in these lodgment records remain as unidentified species; in addition, some of the "known" species have not been formally identified. In the case where specimens have been re-described to a new genus or new family, the current name of the species is recorded first, followed by commentary with the name of species when lodged (or originally described). By taxonomic convention, where a species is re-assigned to a new genus or family grouping, the original species name is usually retained, followed in brackets by the name of the taxonomist who originally described (and named) that species e.g., *Tasmanorites flavipes* (Lea), was originally described as *Idacarabus flavipes* by Arthur Lea in 1910, then was subsequently re-described to the genus: *"Tasmanorites"* by Barry Moore in 1972.

The species are listed according to family groups within the broad classifications of phylum, class or order, and follow the systematic ordering scheme given for Tasmanian cave fauna in Eberhard, et. al., 1991. Some added commentary provides relevant data on the taxonomic history of listed species, particularly where species have been re-described, and where known - the present (or past) species authority (taxonomist) is given. In addition, for particular unusual species such as the Gordiacean horse-hair worm, some comment on the species occurrence in Tasmanian caves is provided, along with their usual habitat or ecological status. The collection details for each of the species listed below are contained in the following section of lodgment records from the caves of nine separate karst areas in Tasmania.

Phylum Aschelminthes:

Nematoda

- Aquatic(?) nematode (Probably as below - an unidentified species of the Gordiacean horse-hair worm).

Nematomorpha

- Gordiidae: *Gordius* sp. (horse-hair worm).

[Although often referred to as a *"horse-hair worm"* the taxonomic relationships of the Gordiidae including *Gordius* sp. is unclear. Their listing here as "Nematomorpha" follows the classification in Eberhard

et. al., 1991, where nematoda and nematomorpha are listed separately to distinguish species such as *Gordius* from the "nematodes". However, the usage of the name "Nematomorpha" emanates from Vandel (1965) who originally used the term as a classification to include both the Nematoda and related (?) forms like the Gordiidae (which some taxonomists would still include as Nematoda). The gordiid species are often observed in aquatic habitats (cave pools or gently flowing streams) appearing as a thin, almost hair like, spirally twisted pale-coloured "worms" up to 10cm long. This is actually a terrestrial species (known to be parasite), typically found in caves after emerging from the abdomen of larger terrestrial invertebrates, such as the Tasmanian Cave Spider (Clarke, 1989) or the larger cave crickets, of the genus *Micropathus*.]

Phylum Arthropoda:

Class Arachnida: Order Opiliones (harvestman)

Triaenonychidae: *Hickmanoxyomma gibbergunyar* (harvestman);

Triaenonychidae: *Hickmanoxyomma cavaticum* (Hickman) [Variety 1*].

Triaenonychidae: *Hickmanoxyomma cavaticum* (Hickman) [Variety 2*].

Cavernicolous species of the genus: *Hickmanoxyomma* were previously assigned to the genus: *Monoxyomma* as defined by Hickman (1958) for the type species: *Monoxyomma cavaticum*, but re-described to *Hickmanoxyomma* by Hunt (1990) who defined three species groups in this "new" genus, including *H. cavaticum*. * The studies by Hunt indicate that there are slight morphological variations, but distinct enzyme differences between specimens from the separated cave populations of *H. cavaticum* in the nearby karst areas of Ida Bay, Hastings and North Lune (Hunt, 1990). As asterisked above (and with permission from the author: the late Dr. Glenn Hunt), the "electro-morphs" of these separate populations have been assigned as varieties: "Variety 1" - Ida Bay, "Variety 2" - Hastings and "Variety 3" - North Lune (Clarke, in prep.).

Class Arachnida: Order Pseudoscorpionida (pseudoscorpion)

- Chthoniidae: *Pseudotyrannochthonius typhlus* (Species probably not formally identified at SAM).

Class Arachnida: Order Araneae

- Austrochilidae: *Hickmania troglodytes* (Higgins & Petterd) - Tasmanian Cave Spider

The Tasmanian Cave Spider was originally described by Higgins & Petterd as *Theridion troglodytes* in the family Arachnidae (Higgins & Petterd, 1883), collected from an un-named cave at Mole Creek, now believed to be *Baldocks Cave* (Clarke, 1999). The spider has been subsequently re-described (or re-classified) three times - as Hypochilidae: *Ectatostica troglodytes* by Rainbow in 1904; Hypochilidae: *Hickmania troglodytes* by Gertsch in 1958; and more recently as *Hickmania troglodytes* in the family: Austrochilidae, sub-family: Hickmaniinae by Forster, et al. 1987 (Doran, 1991).

- Stiphiidae: *Stiphidion facetum* (cave spider);
- Theridiidae: *Steatoda* sp. nov. A (cave spider);
- Theridiidae: undetermined species (cave spider);
- Theridiosomatidae: undetermined species (cave spider);
- Family unknown: undetermined species (cave spider);
- Family or Families unknown: 2-3 (?) undetermined species (possibly epigean spiders).

Class Arachnida: Order Acarina (mites and ticks)

- Family unknown: unidentified species (mite).

Class Crustacea: Order Anaspidacea (anaspidean syncarid crustacean)

- Anaspididae: *Anaspides tasmaniae*.

Class Crustacea: Order Isopoda (isopods or "slaters")

- Styloniscidae: *Styloniscus* sp.;

(Probably *Stylonsicus nichollsi*, but SAM specimens have not been formally identified.)

- Armadillidae: *Echinodilla cavaticus*.

Collected from a cave on Flinders Island in the Furneaux Group this species was described as *Echinodilla cavaticus* by Green (1963); the specimens in the SAM collection are mistakenly recorded as "*E. cavaticum*".

Class Diplopoda: (millipedes)

- Dalodesmidae: unidentified species.

One of these unidentified species was collected from *Cashion Creek Cave* in the Junee-Florentine, from a site where further specimens collected by A. and T. Goede (on 17-iii-1968) were identified by P. Johns (New Zealand) as species of *Pseudoprionopeltis hardyi* (Goede records).

- Unknown Family: unidentified species.

Class Chilopoda: (centipede)

- Unknown Family: unidentified species.

Class Symphyla: (symphylan)

- Unknown Family: unidentified species.

Class Insecta: Sub-Class Collembola (springtail)

- Unknown Family: unidentified species.
- Leptophlebiidae: unidentified species.

Class Insecta: Sub-Class Orthoptera: (cave cricket or weta).

- Rhaphidophoridae: *Micropathus* sp.
- Rhaphidophoridae: *Micropathus cavernicola*;
- Rhaphidophoridae: *Micropathus tasmaniensis*;
- Rhaphidophoridae: *Parvotettix goedei*;
- Rhaphidophoridae: *Cavernotettix flinderensis* (Chopard).

The cave cricket species: *Cavernotettix flinderensis* was re-described and reassigned to its new genus (Cavernotettix) by Richards (in 1966), following its original description by Chopard (in 1944) as *Speleotettix flinderensis* (Richards, 1967). Richards states that the original species description as *S. flinderensis* by Chopard was based on a single (desiccated) specimen of a male nymph (Richards, 1967); both this holotype male (nymph) and a paratype male nymph are lodged in the dry collection of the South Australian Museum.

Class Insecta: Sub-Class Coleoptera: beetles.

- Dascillidae: *Cyphon doctus*;
- Cryptophagidae: *Cryptophagus troglodytes*;

Although not reported from Tasmanian caves since 1909 and possibly an accidental species, these cryptophagids are often found in caves of eastern Australia. All these species should be assigned to the genus: *Atomaria* (E. Hamilton-Smith, pers. comm.).

- Carabidae: *Tasmanorites flavipes* (Lea)

This species was described by A.M. Lea as *Idacarabus flavipes* (Lea, 1910), then re-described (and re-assigned) to the genus *Tasmanorites* by B.P. Moore (Moore, 1972).

- Carabidae: *Tasmanotrechus cockerilli*;
- Carabidae: *Idacarabus troglodytes*;
- Carabidae: *Idacarabus cordicollis*;
- Carabidae: *Idacarabus longicollis*;
- Carabidae: *Goedetrechus mendumae*;
- Carabidae: *Goedetrechus parallelus*.

Class Insecta: Sub-Class Diptera

- Sciaridae: unidentified species (fungus fly);
- Tipulidae: unidentified species (crane fly);
- Mycetophilidae: *Arachnocampa tasmaniensis* (fungus gnat/ glowworm).

Phylum Mollusca:

Class Gastropoda:

- Rhytididae: *Tasmaphena sinclairi* (land snail).

Distribution records for species from Tasmanian caves and karst areas in the South Australian Museum:

Nine karst areas in Tasmania are represented by the specimens and species known or purported to be in the South Australian Museum (see Figure 1). The karst areas are listed in alphabetical order, along with their respective karst area "letter codes", as recorded in the 1985 Australian Speleological Federation (ASF) Karst Index (Matthews, 1985): "E" = Eugenana, "F" = Franklin, "H" = Hastings, "IB" = Ida Bay, "JF" = Junee-Florentine, "LO" = Lorinna, "MC" = Mole Creek, "PB" = Precipitous Bluff and "RA" = Ranga.

In the following list of distribution records, each karst area heading includes a summary of the number of caves represented by the lodgment records, plus the number of specimens and number of species recorded for the karst area, including "unidentified" species (if any). Under each karst area heading, there are some introductory remarks about the location, geology and number of known caves in the karst area, plus historical annotations where relevant to the collection records for that karst area. The lodgment records of specimens are listed according to their species groups (for each karst area), in the same systematic ordering for species, as in previous section. All records are listed by family name, genus and species, if identified (or otherwise recorded as "undetermined species"); common names of animal types are shown in brackets. In order to give an historical perspective to the Tasmanian collection, the specimens are listed in chronological order of collection date, for each species in that karst area. Based on the information given with museum lodgment labels and/or from the reference sources (including the BS Card Index), each record includes the following entries in the same general format:

- "BS" Card Index number and/or museum registration number - where no registration number is

recorded or known, the record begins at the next entry;

- Number of specimens, sex (if known) and "type" status (if any) - where specimen details are not known, the record begins at the next entry;
- Cave name (if known) and cave number;
- Collector's name with date of collection in brackets and month component (if known) in Roman numerals (as per standard convention amongst biologists);
- Name of person (where known) determining the identification of a specimen (as "det.") and year of determination, if known (otherwise as "no date");
- Location of the "sighted" specimen at SAM - as "dry collection" or "spirit collection";
- Search status in the museum (during September 1997) - as "[Sighted]" or "[Not sighted]";
- If not sighted, the reference source(s), that purport(s) the species or specimen as being lodged in SAM, is provided.

The known [sighted] and purported [not sighted] lodgment records for each species group or family are listed as dot points. Each dot point represents a separate record for collector name and/or date of collection. In instances where there is more than one collection record or registration with the same collection details, these are included in the same dot point.

E: Eugenana karst area - 1 cave; 18 specimens, 1 species

Ordovician Gordon limestone: a small karst area west of Spreyton in NW Tasmania - rhaphidophorid (cave cricket) specimens collected from the only known cave, located near a limestone quarry.

Rhaphidophoridae: *Parvotettix goedei* (cave cricket)

- BS1850: 2 females, 2 males & 1 juvenile; *Sherrils Cave* (E-201); T. and A. Goede (22-ii-1969); det. A.M. Richards (no date); spirit collection; [Sighted].
- 8 females & 5 males; *Sherrils Cave* (E-201); A. Goede (22-ii-1969); det. A.M. Richards (no date); [Not sighted in September 1997, but lodgment previously confirmed by SAM staff on September 16th 1996.]; Richards (1970), Goede records.

F: Franklin (River) karst area - 1 cave; 1 specimen; 1 species

Ordovician Gordon limestone: broad area of karst adjoining the Franklin River in western Tasmania – 74 known caves.

Rhaphidophoridae: *Micropathus cavernicola* (cave cricket)

- 1 female (PARATYPE); unknown cave, located near Gordon River junction; R. Scott (1962); det. A.M. Richards (1964); [Not sighted]; Richards (1964).

H: Hastings karst area - 2 caves; 33 specimens; 8 species (plus 1 unidentified species)

Pre-Cambrian dolomite: large karst area in southern Tasmania, 110km south of Hobart – 21 known caves and nearby thermal springs; (adjoins North Lune karst area) and is located 7-8km north of Ida Bay karst area.

Gordiidae: *Gordius* sp. aquatic (?) species (horse-hair worm)

- BS0441 (=V2304): 1 specimen; *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); not formally identified - shown as "Nematomorpha" on BS card; spirit collection; [Sighted].

Triaenonychidae: *Hickmanoxyomma cavaticum* [Variety 2] (harvestman)

- BS0439: 1 specimen (sex not given); *King George V Cave* (H-214); E. Hamilton-Smith (11-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.
- BS0440 (ARA 623): 1 adult male; *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); det. G. Hunt (no date); spirit collection; [Sighted].

Austrochilidae: *Hickmania troglodytes* (Tasmanian Cave Spider) [All single specimens; no sex given.]

- BS0431; BS0432: *Newdegate Cave* (H-X7); E. Hamilton-Smith (13-xi-1963); det. E. Hamilton-Smith; [Both sighted].
- BS0443; BS0444; BS0445; and BS0446: *King George V Cave* (H-214); E. Hamilton-Smith (11-xi-1963); det. E. Hamilton-Smith; [All sighted].

Styloniscidae: Styloniscus sp. (isopod)

- BS0428: 3 specimens; *Newdegate Cave* (H-X7); E. Hamilton-Smith (13-xi-1963); not formally identified; spirit collection; [Sighted].
- BS0437: *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); not formally identified; spirit collection; [Sighted].

Rhaphidophoridae: *Micropathus tasmaniensis* (cave cricket)

- BS0430: 1 female, 4 males and 2 juveniles; *Newdegate Cave* (H-X7); E. Hamilton-Smith (13-xi-1963); det. A.M. Richards (10-ii-1965); spirit collection; [Sighted].
- BS0442: 1 female & 4 males; *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); det.

A.M. Richards (10-ii-1965); spirit collection; [Sighted].

Carabidae: *Idacarabus cordicollis* (cave beetle)

- BS0433: 1 male (HOLOTYPE); BS0434; 1 female (ALLOTYPE); *Newdegate Cave* (H-X7); E. Hamilton-Smith (13-xi-1963); det. B.P. Moore (1967); [Both sighted].
- BS0435: 1 female (PARATYPE); BS0436; 1 male & 1 juvenile (PARATYPES); *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); det. B.P. Moore (1967); [All sighted].

Sciaridae: unidentified species (fungus fly)

- BS0429: *Newdegate Cave* (H-X7); E. Hamilton-Smith (13-xi-1963); not formally identified; [Not sighted]; BS Card Index.
- BS0438: *King George V Cave* (H-214); E. Hamilton-Smith (14-xi-1963); not formally identified; [Not sighted]; Clarke (1997a), BS Card Index.

IB: Ida Bay karst area - 3 caves; 84 specimens; 8 species (plus 4 unidentified species)

Over 235 caves are recorded from this area of Ida Bay (Ordovician) limestone, where timber loggers made the first cave discoveries in this region during the late 1880's. Although *Exit Cave* may also have been known from around this time, it was less accessible and the earliest descriptions of cave visits describe the cave we know today as *Mystery Creek Cave* (also referred to as *Entrance Cave* in some literature sources). In the early 1890's, this site was also known as "*The Queen's Caves*" and the "*Queen Victoria Caves*". In November 1895 it was referred to as "*The Glowworm Caves of Tasmania*", when described by an anonymous author in *Scientific American*. Around the turn of the century, when Arthur Lea first collected cave fauna in this cave (in 1901), the site was more generally known as the "*Ida Bay Caves*". (Another nearby cave: *Bradley Chesterman Cave*, was also discovered around this time, but although poorly documented, it does not appear to be the site for any early recorded collections of cave fauna.) Lea also collected cave fauna from the *Ida Bay Caves* in December 1909 and the label with glowworm specimens records the collection site "*...in total darkness, fully ½ mile from entrance...*" (Ferguson, 1925).

Triaenonychidae: *Hickmanoxyomma cavaticum* [Variety 1] (harvestman)

- ARA 623: 1 female; *Mystery Creek Cave* (IB-10); A.M. Lea (December 1909); det. G.S. Hunt (01-ii-1976); spirit collection; [Sighted].
- BS0449: *Mystery Creek Cave* (IB-10); E. Hamilton-Smith (15-xi-1963); det. G.S. Hunt (1976); [Not sighted]; Clarke (1997a), BS Card Index.
- 1 female & 1 male; A. Goede (22-xii-1964); det. G.S. Hunt (1976); spirit collection; [Sighted]. [Recorded in Hunt (1990) as being lodged in the Tasmanian Museum and Art Gallery (TMAG).]
- BS1844: 1 male; *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); det. G.S. Hunt (01-ii-1976); spirit collection; [Sighted].
- BS2049: *Loons Cave* (IB-2); E. Hamilton-Smith (01-i-1971); [Not sighted]; Clarke (1997a), BS Card index.

Order Aranae (Spiders) - Family unknown: undetermined species

- BS0447; BS0448: *Mystery Creek Cave* (IB-10); E. Hamilton-Smith (15-xi-1963); [Not sighted]; Clarke (1997a), BS Card index.

Anaspididae: *Anaspides tasmaniae* (syncarid crustacean)

- BS1848: *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); det. W.D. Williams (1965); spirit collection; [Sighted].

Diplopoda (millipede) - unknown Family: unidentified species

- BS0939: *Exit Cave* (IB-14); A. Goede (07-i-1965); [Not sighted]; Clarke (1997a), BS Card Index, Goede records.
- BS1847: *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); [Not sighted]; Clarke (1997a), BS Card Index.

Dalodesmidae (millipede): unidentified species

- BS2050: *Loons Cave* (IB-2); E. Hamilton-Smith (01-i-1971); [Not sighted]; Clarke (1997a), BS Card Index.

Symphyla (symphylan): - unknown Family: unidentified species

- BS1846: *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); [Not sighted]; Clarke (1997a), BS Card Index.
- BS2051: *Loons Cave* (IB-2); E. Hamilton-Smith (01-i-1971); [Not sighted]; Clarke (1997a), BS Card Index.

Rhaphidophoridae: *Micropathus tasmaniensis* (cave cricket)

- *Mystery Creek Cave* (IB-10); A.M. Lea (December 1909); det. A.M. Richards (1971); [Not sighted]; Richards, (1971).
- BS0450: 1 female & 1 male; *Mystery Creek Cave* (IB-10); E. Hamilton-Smith (15-xi-1963); det. A.M. Richards (10-ii-1965); spirit collection; [Sighted].
- BS1845: 2 males; *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); spirit collection; [Sighted].
- BS2048: 1 female & 1 male; *Loons Cave* (IB-2); E.

Hamilton-Smith (01-i-1971); det. A.M. Richards (no date); spirit collection; [Sighted].

Carabidae: *Tasmanorites flavipes* (Lea) (cave beetle)

- 1 specimen (HOLOTYPE); *Mystery Creek Cave* (IB-10) recorded as *"Ida Bay Caves"*; A.M. Lea (January, 1901); det. A.M. Lea (1910) as *Idacarabus flavipes*; dry collection; [Sighted].
- 1 female (TYPE LOCALITY SPECIMEN); *Mystery Creek Cave* (IB-10); J.O. Dawson (December 1909); det. A.M. Lea (1910); [Not sighted]; Lea (1910).

Carabidae: *Idacarabus troglodytes* (cave beetle)

- 7 adults: male & female (HOLOTYPE male and female, plus PARATYPES); *Mystery Creek Cave* (IB-10); J.O Dawson and A.M. Lea (December 1909); det. A.M. Lea (1910); [Not sighted]; Lea (1910).
- BS1852; BS1853: *Exit Cave* (IB-14); E. Hamilton-Smith (24-v-1969); [Not sighted]; Clarke (1997a), BS Card Index.
- BS1880: *Exit Cave* (IB-14); B.P. Moore (22-iii-1969); [Not sighted]; Clarke (1997a), BS Card Index.
- BS1881: *Exit Cave* (IB-14); B.P. Moore (23-iii-1969); [Not sighted]; Clarke (1997a), BS Card Index.
- BS2052; BS2053: *Exit Cave* (IB-14); E. Hamilton-Smith (02-i-1971); [Not sighted]; Clarke (1997a), BS Card Index.

Carabidae: *Goedetrechus mendumae* (cave beetle)

- BS1854: 1 male (PARATYPE); BS1855: 1 female (PARATYPE); From *Kellers Squeeze* passage in *Exit Cave* (IB-14); A. Goede and E. Hamilton-Smith (24-v-1969); det. B.P. Moore (1971); spirit collection; [Both sighted].
- Possibly BS1856 (?): Specimen "missing" from empty slot in dry collection; [Not sighted]; Moore (1972), BS card Index.

Dascillidae: *Cyphon doctus* (cave beetle)

- *Mystery Creek Cave* (IB-10); J.O. Dawson and A.M. Lea (December, 1909); det. A.M. Lea (1910), determination based on one live specimen and several dead specimens; [Not sighted]; Lea (1910).

Mycetophilidae: *Arachnocampa tasmaniensis* (fungus gnat / glowworm)

- 1 male (HOLOTYPE); 1 female (ALLOTYPE); *Mystery Creek Cave* (IB-10) recorded as *"Ida Bay Caves"*; A.M. Lea (December, 1909); det. E.W. Ferguson (1925); [Not sighted]; Ferguson (1925), Harrison (1966).
- *Mystery Creek Cave* (IB-10) recorded as *"Ida Bay Caves"*; possibly collected by Ferguson (1925); det. Ferguson (1925); [Not sighted]; Ferguson (1925).
- BS0451: Adult male & female; BS0452: Adult male & female; BS0453: Adult male & female; BS0454: 2 adult males; BS0455: 2 adults (with wings moulting); BS0456: 2 adult males; all specimens: *Mystery Creek Cave* (IB-10); E. Hamilton-Smith (15-xi-1963); det. R.A. Harrison (1966); spirit collection; [Sighted].
- 3 larvae; *Exit Cave* (IB-14); A. Goede (January 1965); det. R.A. Harrison (1966); [Not sighted]; Goede records.
- BS1227: - 25 x larvae; *Mystery Creek Cave* (IB-10); A. Goede (10-x-1965); det. R.A. Harrison; spirit collection; [Sighted].

JF: Junee-Florentine karst area - 4 caves; 51 specimens; 4 species (plus 2 unidentified species)

An extensive area of Ordovician limestone with substantial vertical relief, located in the Junee River and Florentine River valleys, near Maydena in southern Tasmania. Over 585 caves have been recorded in this karst area. Although there are references to caves and karst here since the mid-1830's, there are no known records of early cave fauna collections being lodged in the South Australian Museum.

Theridiosomatidae (spider): undetermined species

- 760425: 1 adult male & 1 penultimate male; *Womguano* [formerly known as *Beginners Luck Cave*] (JF-80); A. Davey (02-iv-1976); spirit collection; [Sighted].

Dalodesmidae (millipede): unidentified species.

- BS0938: *Cashion Creek Cave* (JF-6); A. Goede (29-xii-1964); [Not sighted].

[Possibly the same as species subsequently collected from the same site by A. and T. Goede on 17-iii-1968 and identified by P. Johns (New Zealand) as: *Pseudoprionopeltis hardyi*]

Rhaphidophoridae: *Micropathus tasmaniensis* (cave cricket)

- 76042/4: 2 females & 1 male; *Khazad Dum* (JF-4); A. Davey (02-iv-1976); spirit collection; [Sighted].

Carabidae: *Goedetrechus parallelus* (cave beetle)

- 1 adult (PARATYPE); *Cashion Creek Cave* (JF-6); A. and T. Goede; (17-iii-1968); det. B.P. Moore (1972); in dry collection; [Sighted].
- 1 adult (PARATYPE); *Cashion Creek Cave* (JF-6); A. and T. Goede; (08-xi-1970); det. B.P. Moore (1972); in dry collection; [Sighted].
- No museum number: 2 specimens; no cave details

or collection details; det. B.P. Moore (1972); [Sighted].

- (PARATYPE); *Frankcombe Cave* (JF-7); A. and T. Goede (15-xi-1970); det. B.P. Moore (1972); [Not sighted]; Moore (1972), Goede records.

Mycetophilidae: *Arachnocampa tasmaniensis* (fungus gnat / glowworm)

- 21 x Larvae; *Cashion Creek Cave* (JF-6); A. Goede (29-xii-1964); det. R.A. Harrison (1966); [Not sighted]; Harrison (1966).
- BS1228: 40 x Larvae; *Cashion Creek Cave* (JF-6); A. Goede (31-x-1965); det. R.A. Harrison (1966); spirit collection; [Sighted].
- 76042/4: 2 larvae; *Khazad Dum* (JF-4); A. Davey (02-iv-1976); not formally identified; spirit collection; [Sighted].

Rhytididae: *Tasmaphena sinclairi* (land snail)

- 76042/4: *Khazad Dum* (JF-4); A. Davey (02-iv-1976); spirit collection; [Sighted].

LO: Lorinna karst area - 1 cave; 4 specimens; 3 species.

Small Ordovician limestone area located southwest of Gowrie Park in northern Tasmania: six known caves.

Austrochilidae: *Hickmania troglodytes* (Tasmanian Cave Spider)

- BS2056: *Canned Crawl* (LO-202); E. Hamilton-Smith (16-i-1971); det. E. Hamilton-Smith; [Not sighted]; Clarke (1997a), BS Card index.

Rhaphidophoridae: *Micropathus* sp. (cave cricket)

- BS2055: - 2 males; *Canned Crawl* (LO-202); E. Hamilton-Smith (16-i-1971); not formally identified; spirit collection; [Sighted].

Sciaridae: unidentified species (fungus fly)

- BS2057: *Canned Crawl* (LO-202); E. Hamilton-Smith (16-i-1971); [Not sighted]; Clarke (1997a), BS Card Index.

MC: Mole Creek karst area - 8 caves; 93 specimens; 10 species (plus 13 un-identified species)

A large area of Ordovician limestone west of Deloraine in northern Tasmania where 360 caves are recorded (Clarke, in press). The actual cave name locations for some of the earlier collected cave species from Mole Creek, e.g., A.M. Lea (c. 1901) and R.H. Pulleine (c. 1924), are not precisely recorded, other than as "Mole Creek Caves". Despite the "plural" name, implying more than one cave (as individual cave sites were referred to in historical times), it is possible that these specimens all came from the same cave. Recent historical research of early cave discoveries in the Mole Creek district indicates that around the late 1800's and early 1900's, the known caves in this district were located in two areas and referred to as the "old Chudleigh Caves" and the "new" *Mole Creek Caves* (Clarke, 1999a). The *Chudleigh Caves* included the two earlier known adjoining sites: *Wet Cave* and *Honeycomb* near Caveside, whereas the *Mole Creek Caves* became a collective name for the more recently discovered "new" caves in the south Mole Creek district, such as *Sassafras Cave* and *Cyclops Cave*, plus the two early tourist caves: *Baldocks Cave* and *Scotts Cave*. An un-named cave in this Mole Creek area was the site locality for the first description of an invertebrate species from a Tasmanian cave (in 1883): initially described as *Theridion troglodytes – "a new cave-inhabiting spider"* (Higgins & Petterd, 1883), it has subsequently been referred to as the Tasmanian Cave Spider. Recent historical research suggests that this "un-named cave" is most likely to be Baldocks Cave (Clarke, 1999a) and it is possible that this may have been the site where Lea collected his cave cricket, spider and harvestman specimens in 1901. (The two more distant and more recently discovered tourist caves: *King Solomons Cave* and *Marakoopa Cave*, also became later known as the *Mole Creek Caves*.)

Phylum Aschelminthes: unidentified species of Gordiacean horse-hair worm (?)

- BS1773 (=V2300): *Scotts Cave* (MC-52); E. Hamilton-Smith (05-ix-1968); listed as "Nematoda" on BS card; not formally identified; spirit collection; [Sighted].

Triaenonychidae: *Hickmanoxyomma gibbergunyar* (harvestman)

- Label as *"Mole Creek Caves"*; A.M. Lea (January, 1901); not formally identified; spirit collection; [Sighted]. (Specimen found in SAM collection of "non-identified" spider species. Vial also contains unidentified theridiid spider; both specimens sent from SAM to Glenn Hunt for identification at the Australian Museum, September 1997.)
- BS1849: *Scotts Cave* (MC-52); E. Hamilton-Smith (12-v-1969); [Not Sighted]; Clarke (1997a), BS Card Index.
- BS2054: *Herberts Pot* (MC-202); W. Grimm (15-i-1971); [Not Sighted]; Clarke (1997a), BS Card Index.

Chthoniidae: *Pseudotyrannochthonius typhlus* (pseudoscorpion)

- BS1769 (= N197919): *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); probably not formally identified; spirit collection; [Sighted].

Theridiidae: undetermined species (spider)

- Label as *"Mole Creek Caves"*; A.M. Lea (January,

1901); specimen not identified; spirit collection; dispatched to G.S. Hunt (Australian Museum), along with unidentified harvestman, Sept. 1997; [Sighted].

Theridiidae: *Steatoda* sp. nov. A (cave spider)

- BS0459: *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); det. M.R. Gray (1973); [Not sighted]; Gray (1973), BS Card Index.

Austrochilidae: *Hickmania troglodytes* (Tasmanian Cave Spider)

- 1 female & 2 males; 2 females & 3 males; label shows *"Mole Creek cave"*; R.H. Pulleine (1924); museum label records it as: *"Ectatostica troglodytes"* (Family: Hypochilidae); spirit collection; [All specimens sighted].
- BS0467: *Baldocks Cave* (MC-32); E. Hamilton-Smith (19-xi-1963); [Not Sighted]; Clarke (1997a), BS Card Index.
- BS1465; *Diamond Cave* (MC-6), A.M. Richards (11-ix-1966), [Not Sighted]; Clarke (1997a), BS Card Index.

Stiphiidae: *Stiphidion facetum* (cave spider)

- BS1537; *Baldocks Cave* (MC-32); A.M. Richards (11-ix-1966); det. M.R. Gray; [Not sighted]; Gray (1973), BS Card Index.

Order Aranae (spiders): Family unknown; undetermined species

- 8 specimens, possibly 2-3 separate species, including apparent epigean (surface dwelling) spiders; label shows: *"Mole Creek Caves"*; R.H. Pulleine (1924); species not identified; spirit collection; [Sighted].
- BS0460; *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.

Acarina - (Family unknown): unidentified species of mite

- BS1772: *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); [Not sighted]; Clarke (1997a), BS Card Index.

Anaspididae: *Anaspides tasmaniae* (syncarid crustacean)

- BS0457: 1 female & 2 juveniles; *Sassafras Cave* (MC-96); E. Hamilton-Smith (18-xi-1963); det. W.D. Williams (1965); spirit collection; [Sighted].
- BS0464: 2 females, 2 males & 1 juvenile; *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); det. W.D. Williams (1965); spirit collection; [Sighted].

Styloniscidae: *Styloniscus* sp. (isopod)

- BS0461: *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); not formally identified; spirit collection; [Sighted].
- BS1776: Five (5) specimens; *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); not formally identified; spirit collection; [Sighted].

Dalodesmidae (millipede): unidentified species

- BS1767; BS1768: *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); [Not sighted]; Clarke (1997a), BS Card Index.

Chilopoda (centipede): unknown Family; unidentified species

- BS1771: *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); [Not sighted]; Clarke (1997a), BS Card Index.

Collembola (springtail): unknown Family; unidentified species

- BS1774; BS1775: *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); [Not sighted]; Clarke (1997a), BS Card Index.

Rhaphidophoridae: *Micropathus cavernicola* (cave cricket)

- 7 females, 7 males & 8 juveniles; Mole Creek: (*Mole Creek Caves*); A.M. Lea (January, 1901); det. A.M. Richards (1962); dry collection; [Sighted].
- 1 male specimen (PARATYPE), with dismembered legs; *Marakoopa Cave* (MC-120) Type Locality; A. Goede (28-vii-1957); det. A.M. Richards (1962); spirit collection; [Sighted].
- 1 female specimen (PARATYPE); *Marakoopa Cave* (MC-120) Type Locality; A. Goede (28-vii-1957); det. A.M. Richards (1962); spirit collection; [Sighted].
- BS0465: - 3 females & 3 males (most specimens with dismembered legs); *Baldocks Cave* (MC-32); E. Hamilton-Smith (19-xi-1963); det. A.M. Richards (10-ii-1965); spirit collection; [Sighted].
- BS1588: 1 x male; *Diamond Cave* (MC-6); P.A. Richards (11-ix-1966); det. A.M. Richards (1966); spirit collection; [Sighted].
- BS1777: 1 female; *Cyclops Cave* (MC-17); E. Hamilton-Smith (16-ix-1968); not formally identified; spirit collection; [Sighted].

Cryptophagidae: *Cryptophagus troglodytes* (cave beetle)

- 1 specimen, unknown sex (HOLOTYPE); 3 females (PARATYPES): *Scotts Cave* (MC-52); collected *"...a long way from the entrance to the caves..."*; R.A. Black (December 1909); det. A.M. Lea (1910); [Not sighted]; Lea (1910). [Should be recorded as: *Atomaria troglodytes* (Lea); E. Hamilton-Smith, pers. comm.]

Carabidae: *Tasmanotrechus cockerilli* (cave beetle)

Tasmanian cave fauna.

- No "SAM" Number; (PARATYPE); *Georgies Hall* (MC-201); R.J. Cockerill (January, 1968); det. B.P. Moore (1972); specimen "missing" from dry collection on September 8th1997; [Not sighted]; Moore (1972).
- BS1882: 1 female and 1 male (PARATYPES); *Scotts Cave* (MC-52); A. Goede (21-ix-1968); det. B.P. Moore (1972); [Not sighted]; Moore (1972); BS Card Index.

Tipulidae (crane fly): unidentified species

- BS0458: *Sassafras Cave* (MC-96); E. Hamilton-Smith (18-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.
- BS0463: *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.
- BS0466: *Baldocks Cave* (MC-32); E. Hamilton-Smith (19-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.

Leptophlebiidae (mayfly): unidentified species

- BS0462: *Marakoopa Cave* (MC-120); E. Hamilton-Smith (19-xi-1963); [Not sighted]; Clarke (1997a), BS Card Index.

Sciaridae (fungus fly): unidentified species

- BS1770; BS1778: *Scotts Cave* (MC-52); E. Hamilton-Smith (15-ix-1968); [Not sighted]; Clarke (1997a), BS Card Index.

PB: Precipitous Bluff karst area - 1 cave; 3 specimens; 1 species

An area of Ordovician limestone karst, located near the south coast of Tasmania – with over forty known caves; speleological research is comparatively recent, dating back to early 1970's.

Carabidae: *Idacarabus longicollis* (cave beetle)

- 1 male (HOLOTYPE); *Damper Cave* (PB-1); K. Kiernan (16-i-1973); det. B.P. Moore (1978); [Not sighted]; Moore (1978).

RA: Ranga karst area (Flinders Island) - 2 caves; 5 specimens; 2 species

A small area of karst in Pleistocene dune limestone with three known caves (on private property), located near Strezlecki Peak on Flinders Island: the largest one of the Furneaux (Group) Islands off the NE tip of Tasmania.

Armadillidae: *Echinodilla cavaticus* (isopod)

- BS1851: 7 specimens; *Ranga Cave* (RA-X1); A. Goede (09-i-1969); det. A. Green (1972); label records specimen as *"E. cavaticum"*; spirit collection; [Sighted].

Rhaphidophoridae: *Cavernotettix flinderensis* (Chopard) (cave cricket)

- 1 male (HOLOTYPE); 1 male (PARATYPE); un-named cave (RA-X2), near Strezlecki Peak; H.H. Finlayson (January, 1930); initial det. L. Chopard (in 1944) as *Speleotettix flinderensis*; subsequent det. as *Cavernotettix flinderensis* (Chopard) by A.M. Richards (1967); dry collection; [Sighted].
- BS0402: 2 males; *Ranga Cave* (RA-X1); A. Dart (23-v-1963); det. A.M. Richards (1967); spirit collection; [Sighted].

Summary list of the Tasmanian cave "type" specimens known or purported to be at SAM:

The type specimens are considered to be the most important specimens, from a taxonomic and historical perspective, because they relate to the original description of a particular species and display the identifying characteristics that formed the basis or supplementary support for the species description. The "holotype" specimen represents the single sex specimen or pair of specimens (male and female) designated to represent a new species, which is described from the anatomical characteristics of this specimen: the holotype. The cave or site from where the holotype is chosen is usually referred to as the "Type Locality". The chosen holotype, which forms the basis of the species description, may also be supplemented by additional specimens described at the same time, even though from a different site: these specimens are referred to as "paratypes". In instances where an identical specimen of the opposite sex is described from the same site locality as the holotype, this is often referred to as an "allotype" – virtually a paratype of the sex opposite to the holotype.

The following list of 26 "type" specimens (holotypes, paratypes and allotypes) has been extracted from the previous section of lodgment records. The species are listed alphabetically by genus within respective family groups in the same systematic order. The summary below confirms whether these species were sighted during the preliminary research of Tasmanian specimens at SAM during September 1997. Although half the type specimens were not sighted, it is possible that these were located in other parts of the SAM collection, other sections of the museum or out on loan to taxonomists; it is also possible that some of the missing type specimens were not actually lodged with the museum.

Orthoptera – RHAPHIDOPHORIDAE (cave crickets):

Micropathus cavernicola

- 1 male specimen (PARATYPE); *Marakoopa Cave* (MC-120); [Sighted].
- 1 female specimen (PARATYPE); *Marakoopa Cave* (MC-120); [Sighted].
- 1 female (PARATYPE); unknown cave, located near Gordon River junction; [Not sighted]

Cavernotettix flinderensis (Chopard)

- 1 male (HOLOTYPE): un-named cave (RA-X2), Flinders Island; [Sighted].
- 1 male (PARATYPE): data as above; [Sighted].

Coleoptera – CARABIDAE (cave beetles):

Goedetrechus mendumae

- BS1854: 1 male (PARATYPE); *Exit Cave* (IB-14); [Sighted].
- BS1855: 1 female (PARATYPE): *Exit Cave* (IB-14); [Sighted].

Goedetrechus parallelus

- 1 adult (PARATYPE); *Cashion Creek Cave* (JF-6); [Sighted].
- 1 adult (PARATYPE); *Cashion Creek Cave* (JF-6); [Sighted].
- (PARATYPE); *Frankcombe Cave* (JF-7); [Not sighted]

Idacarabus cordicollis

- BS0433: 1 male (HOLOTYPE); *Newdegate Cave* (H-X7); [Sighted]
- BS0434: 1 female (ALLOTYPE); *Newdegate Cave* (H-X7); [Sighted].
- BS0435: 1 female (PARATYPE); *King George V Cave* (H-214); [Sighted].
- BS0436: 1 male & 1 juvenile (PARATYPES); *King George V Cave* (H-214); [Both sighted]

Idacarabus longicollis

- 1 male (HOLOTYPE MALE); *Damper Cave* (PB-1); [Not sighted].

Idacarabus troglodytes

- HOLOTYPE male: *Mystery Creek Cave* (IB-10); [Not sighted]
- HOLOTYPE female: *Mystery Creek Cave* (IB-10); [Not sighted]
- PARATYPES: *Mystery Creek Cave* (IB-10); [Not sighted]

Tasmanorites flavipes (Lea)

- 1 specimen (HOLOTYPE); *Mystery Creek Cave* (IB-10); det. A.M. Lea (1910) as *Idacarabus flavipes*; [Sighted].
- 1 female (TYPE LOCALITY SPECIMEN); *Mystery Creek Cave* (IB-10); [Not sighted]

Tasmanotrechus cockerilli

- (PARATYPE); *Geordie Hall* (MC-201); [Not sighted]:
- BS1882: 1 female and 1 male (PARATYPES); *Scotts Cave* (MC-52); [Not sighted]

Coleoptera – CRYPTOPHAGIDAE (cave beetle)

Cryptophagus troglodytes

- 1 specimen (HOLOTYPE): *Scotts Cave* (MC-52); [Not sighted].
- 3 females (PARATYPES): *Scotts Cave* (MC-52); [Not sighted].

Diptera – MYCETOPHILIDAE (fungus gnat/ glow-worm):

Arachnocampa tasmaniensis

- 1 male (HOLOTYPE); *Mystery Creek Cave* (IB-10); [Not sighted].
- 1 female (ALLOTYPE); *Mystery Creek Cave* (IB-10); [Not sighted].

Discussion and conclusions:

The number of Tasmanian cave species in the South Australian Museum is probably quite small compared to the collections held by the ANIC (Australian National Insect Collection) at CSIRO in Canberra or in the Australian Museum, Sydney. However, the range of cave fauna species groups represented at SAM is broad and reflects the historical interests of the early museum curators, such as Lea as well as the resident taxonomists, including Ferguson and the more recent influence of Hamilton-Smith (who was appointed as Honorary Research Associate in Zoology to SAM in 1964). As listed above, there is also a substantial type collection of Tasmanian cave species in the museum, which in part is probably due to Lea in the first instance, as well as the subsequent presence of Hamilton-Smith as an active biospeleologist with SAM. Although only half of the 26 type specimen lodgments were sighted, it should be noted that 19 type specimens are cave beetles - a fact which further demonstrates the esteem held by SAM as a repository for both beetles and cave fauna and the more recent influence of Hamilton-Smith who helped establish the cave collection.

There was some difficulty in locating specimens within the SAM collection, partly due to the fact that their taxonomic storage had been collated without

reference to index cards. This difficulty in specimen location may in part also represent the historical legacy of the problems associated with the different organisational structures in the enormous SAM collations; with specimens being derived from three principal sources: the private donations, taxonomic museum fieldwork and the environmentally based collections, with similar specimens being housed in different museum sections. During the on-site museum research in September 1997, it was a little disconcerting to note the number of unidentified species (including known species not formally identified). The unidentified species included the spider and harvestman specimens collected from *Mole Creek Caves* by Lea in 1901.

The recent research in this combined study of taxonomists and collectors' lodgment records, the BS cards and actual museum sightings, has yielded a total of 121 lodgment records (including 26 type species lodgments), for 334 specimens of Tasmanian cave species known or purported to be in SAM. In 1997, when the RFA cave fauna database was compiled (Clarke, 1997a; 1997b), there were only 93 recorded lodgments of invertebrates from Tasmanian caves; the additional 28 records have increased our knowledge of the known or purported SAM lodgments by almost a third. Research for this paper has also indicated an unexpected number of almost 40 lodgment records that were not recorded on the Hamilton-Smith BS cards, including other specimens not contained in the known published literature. Further on-site research at SAM would probably reveal additional species and some of the non-sighted specimens in the sections of the collections that were not examined, including the glass slide mounted specimens of smaller species, such as the mites or springtails. It is likely that the figure for total number of specimens in SAM will also increase when further detail is obtained in regard to the hitherto unsighted specimens. Although this research only represented a partial study of the lodgment records in SAM, the preliminary results do indicate some sort of anomaly between the purported lodgments, including type species, contained in published records and the Hamilton-Smith BS card index, compared to the actual known or confirmed sightings of only 69 (or 57%) of the 121 specimen lodgments in the museum collection.

This apparent anomaly in regard to the number of "non-sighted" or "purported" specimens, including the apparent absence of half of the type specimens, may be due to several factors. It is evident that the BS cards were also used to record all records relating to collection or identification of cave species in Australia, although the registration numbers on the BS cards were generally only assigned to record the Hamilton-Smith collection, and all other specimens, actually lodged in SAM. The empty compartment slots indicated that a few of the non-sighted BS card specimens of Tasmanian cave fauna were obviously missing, including the possibility of being out on loan. Although the SAM loans book appeared to be incomplete and not up to date, additional loan records may have been kept elsewhere in the museum. The thirteen unsighted type specimens may be part of another collection of "types" housed separately within the museum. Similarly, some of the other unsighted species including the unidentified cave flies and other insects may also be located in sections of the museum that were not searched. Some discrepancies may simply be explained as items that were never actually lodged in SAM, including specimens forwarded to other institutions subsequent to publication of records, or simply mistakenly recorded to the wrong institution in the published record.

Although the systematic ordering and digital databasing of the reference collections at SAM has probably now commenced, it will take many years to collate their records. In recent years there has been an unfortunate trend away from taxonomic studies and museums have been facing commercial pressures to perform more profitably in other directions, such as public displays, presentations and interpretation, as well as adopting "user-pay" systems for access to information services and museum records.

Acknowledgments:

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References:

CLARKE, A., 1989: *Fauna from the caves and karst of the Bubs Hill area, Western Tasmania*. Report submitted to the Tas. Dept. of Parks, Wildlife & Heritage; 24pp.

CLARKE, A., 1997a: *Unpublished Tasmanian RFA Cave Fauna Database* (Digital database in Microsoft Access - with 3 Tables covering 42 fields and 5,500 records for 672 species); submitted to TASPAWS (GIS) Section of Tasmanian RFA.

CLARKE, A., 1997b: *Management prescriptions for Tasmania's cave fauna*. Report to Tasmanian Regional Forest Agreement (RFA) Environment & Heritage Technical Committee. 167pp. ISBN 0 7246 4578 0

CLARKE, A., In Press: A complete list of the Mole Creek Caves. *Speleo Spiel*, #321 (August-September, 2000).

CLARKE, A., 1999a: Baldocks Cave: the site locality for the Tasmanian Cave Spider (and selected historical references relating to the early discovery of limestone in northern Tasmania and the caves of the Chudleigh [Mole Creek] district. *Cave Management in Australasia 13 - Proceedings of the thirteenth Australasian Conference on Cave and Karst Management*, Mount Gambier, South Australia, 18-24 April, 1999. 130-136.

CLARKE, A., In Prep: New troglobitic cave fauna species in Tasmania, including apparent species varieties of the southern cave harvestman: *Hickmanoxyomma cavaticum*.

DORAN, N., 1991: *Cave adaptation in the Tasmanian Cave Spider, Hickmania troglodytes*. Unpubl. BSc. Honours Thesis, Zoology Dept., Uni. of Tas. 112pp.

EBERHARD, S.M., RICHARSON, A.M.M. AND SWAIN, R., 1991: *The Invertebrate Cave Fauna of Tasmania*. Zoology Dept., University of Tasmania, May 1991. 174pp.

FERGUSON, E.W., 1925: Description of a new species of Mycetophilidae (Diptera) with luminous larvae. *Proc. Linnean Soc. NSW.* **L:** 487-488.

GRAY, M.R., 1973: Survey of the spider fauna of Australian caves. *Helictite*, **11 (3):** 47-75.

GREEN, A.J.A., 1963: A new species of Echinodillo (Isopoda, Oniscoidea, Armadillidae) from Flinders Island, Tasmania. *Papers and Proceedings of the Royal Society of Tasmania*, **97:** 77-80.

HAMILTON-SMITH, E., 1967: *Australian cave fauna: Plans for a survey of species*. Notes of a Paper delivered at the 1962 Conference of the Australian Speleological Conference.

HARRISON, R.A., 1966: Australian glow-worms of the genus Arachnocampa Edwards. *Pacific Insects*, **8 (4):** 877-883.

HICKMAN, V.V., 1958: Some Tasmanian harvestmen of the family Triaenonychidae (sub-order Laniatores). *Papers and Proceedings of the Royal Society of Tasmania*, **92:** 1-116.

HIGGINS, E.T. & PETTERD, W.F., 1883: Description of a new cave-inhabiting spider, together with notes on mammalian remains from a recently discovered cave in the Chudleigh District. *Papers and Proceedings of the Royal Society of Tasmania*, **1883**: 191-192.

HUNT, G.S., 1990: Hickmanoxyomma, a new genus of cavernicolous harvestmen from Tasmania (Opiliones: Triaenonychidae). *Rec. Aust. Museum* (1990), **42:** 45-68.

LEA, A.M., 1910: On some Tasmanian cave-inhabiting beetles. *Tasmanian Naturalist*, **2:** 53-58.

MATTHEWS, P.G., 1985: *Australian Karst Index* 1985. Australian Speleological Federation Inc., Broadway, NSW.

MOORE, B.P., 1967: New Australian Cave Carabidae (Coleoptera) *Proc. Linnean Soc. NSW.* **91 (3):** 179-184.

MOORE, B.P., 1972: A revision of the Australian Trechinae (Coleoptera: Carabidae). *Aust. J. Zoology. Supplement No.* **18** (8 December 1972): 61pp.

MOORE, B.P., 1978: A new species of the Tasmanian cave carabid genus Idacarabus (Coleoptera). *Aust. Entomological Mag.* **5 (2):** 23-25.

MUSGRAVE, A., 1932: *Bibliography of Australian entomology: 1775-1930 with biographical notes on authors and collectors by Anthony Musgrave*. Royal Zoological Society of New South Wales, Sydney. 380pp.

RICHARDS, A.M., 1964: The Rhaphidophoridae (Orthoptera) of Australia, 1: Tasmania. *Pacific Insects*, **6 (1):** 217-223.

RICHARDS, A.M., 1967: The Rhaphidophoridae (Orthoptera) of Australia, 5: The Rhaphidophoridae of Flinders Island. *Proc. Linnean Society of New South Wales*, **92 (2):** 151-156.

RICHARDS, A.M., 1971: The Rhaphidophoridae (Orthoptera) of Australia, 9: The distribution and possible origins of Tasmanian Rhaphidophoridae, with descriptions of two new species. *Pacific Insects*, **13 (3-4):** 575-587.

VANDEL, A., 1965: *Biospeleology: The Biology of Cavernicolous Animals*. International Series of Monographs on Pure and Applied Biology/Zoology Division, Volume 22. Translated B. E. Freeman. Pergamon Press, Oxford, 524 pp.

White, S., 2000: Thermoluminescence dating of dune ridges in western Victoria. *Helictite* **36**(2):38-40.

Thermoluminescence dating of dune ridges in western Victoria

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Abstract

The absolute dating of the Pleistocene dune ridges of southwestern Victoria establishes a time frame for speleogenesis of syngenetic karst in such dune calcarenites.

Introduction:

The karst provinces of southeastern South Australia and southwestern Victoria have a remarkable series of calcareous coastal dunes which have been recognised as stranded beach dunes formed by a combination of successive sea-level high stands and tectonic uplift. The sequence of such dunes between Naracoorte and Robe, South Australia, has been dated using a variety of methods: uranium/thorium (Schwebel, 1984), palaeomagnetism (Idnurm and Cook, 1980) and thermoluminescence (TL) of quartz (Huntley, et al., 1993ab, 1994). The TL dates have been correlated to the oxygen isotopes (δ18O) records for high sea level stands (Huntley, et al., 1994).

Thermoluminescence (TL) dating has the ability to determine the date of burial of the quartz fraction in sediments such as dunes. The TL date is the time elapsed since the quartz grains were last exposed to sunlight. As such, TL dates do not provide a date for either dune lithification or karstification; merely the date of deposition of the sediment. In this sense TL ages provide an upper limit or maximum age for karstification which must be younger than the aeolian deposition of the dunes.

The remarkable dune sequence in the South Australian series has been subjected to relatively steady tectonic uplift in the area around the Glenelg River. The dunes have been dated at between 100 and 800 ka, although there is some discussion on the accuracy of the technique with respect to the oldest dunes especially the West Naracoorte Range (800 ± 100 ka; Huntley, et al., 1994).

East of the Glenelg River the karst provinces show a more complex tectonic history. More disjointed tectonic uplift as indicated by the presence of faults eg. Kanawinka Fault, Swan Lake Fault, makes sea-level estimations more difficult to extrapolate along the dune ridges, as the distribution of the dune limestones is less regular. Between Portland and Warrnambool the dunes are predominantly restricted to a belt along the modern coast. The few older ridges further inland generally have little karst development.

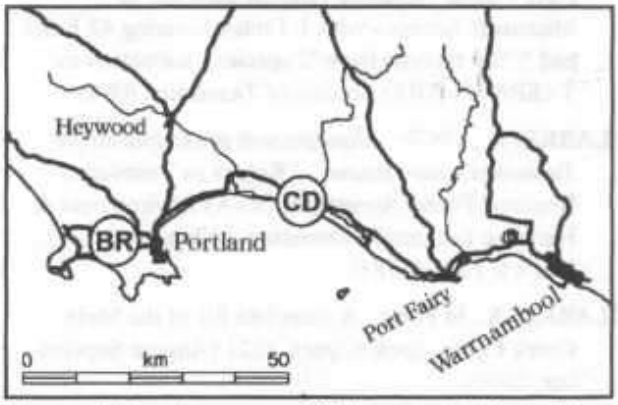

Figure 1: Location map of Codrington (CD) and Bats Ridge (BR).

Between the dune ridges are extensive swampy plains. These include old coastal flats and contain estuarine to lacustrine limestones, dolomites, marls and clays up to 13 m thick (Grimes, et al., 1999). In some cases such interdune areas have been incised into the dune limestone by solutional process indicating karstic development (White, 1994).

The dating of Victorian ridges has been more limited than for the major sequence in South Australia. Two ridges near Codrington (between Port Fairy and Portland) and at Bats Ridge (8km West of Portland) have now been dated using thermoluminescence of quartz. Locations are shown on Figure 1.

The Codrington ridge is approximately 1.5km inland from the present coast and the crest of the dune averages about 20m above present sea level. Samples for TL dating were collected from the dune from within two caves: CD 5 (827633) and CD 13 (813638 - Portland 7221). As the dune calcarenite contains up to 30% quartz, enough quartz grains of 125-180µm diameter were obtained by standard separation methods (Aitken, 1985) under red light for TL analysis. The samples were analysed at Latrobe University laboratory using the regenerative dose (total bleach) method, and the results are shown in Table 1.

The Bats Ridge dune is approximately 4 km inland, 8km west of Portland. The ridge is about 90 m above present sea level and the sample (BR6) was collected from a cave within the ridge at 432565. Quartz grains of 90-125µm diameter were extracted from this sample and were analysed at the Wollongong University TL Dating Laboratory (sample code W2231). The results are shown in Table 2.

Table 1: Codrington: Equivalent Doses, Dose Rates and TL Ages

Sample	Dose Rate Effective α (Gy/ka)	Dose Rate β (Gy/ka)	Dose Rate γ (Gy/ka)	Dose Rate Cosmic (Gy/ka)	Total Dose Rate	Equivalent Dose (Gy)	Plateau Temp Range (°C)	TL Age (ka)
CD-5	0.014 ± 0.007	0.162 ± 0.008	0.132 ± 0.009	0.15 ± 0.02	0.46 ± 0.03	112 ± 33	320-490	244±74
CD-13	0.015 ± 0.007	0.208 ± 0.016	0.153 ±0.015	0.15 ± 0.02	0.53 ±0.04	125± 22	310 - 450	238±45

Radioactive Nucleides and Water Concentrations

Sample	U (ppm)	Th (ppm)	K (%)	H2O (wt %)
CD-5	0.69 ± 0.05	0.68 ± 0.15	0.08	1.0
CD-13	0.76 ± 0.06	0.80 ± 0.18	0.14	5.0

Notes:

- *Cosmic ray dose rate is assumed.*
- *U and Th measured by thick-source alpha counting and seculart equilibrium is assumed.*
- *An alpha efficiency of 0.10± 0.02 is assumed.*
- *K measured by XRF.*
- *Internal dose rate is assumed to be negligible, and has been ignored.*
- *For both samples, equivalent dose calculated from 335 – 400 °C*

Table 2: Bats Ridge (BR6): Equivalent Doses, Dose Rates and TL Age.

Sample	Dose rate (Gy/ka)	Palaeodose (Gy)	Plateau Temp. Range °C	TL Age ka
BR-6	0.572±0 05	166±13	275-500	290±34

Radioactive Nucleides and Water Concentrations

U + Th (Bq/kg)	K (%)	H_2O (Wt%)
16.4 ± 0.5	0.080 ± 0.005	1.4± 3

Notes:

- *The equivalent dose was obtained by means of a combined additive dose and regenerative dose method (eg Huntley et al., 1993a).*
- *Cosmic ray dose rate is assumed as 0.15 ± 0.05 Gy/ka.*
- *U and Th measured by thick-source alpha counting, and secular equilibrium is assumed for both decay chains.*
- *K measured by AES.*
- *Equivalent dose is calculated from 375 °C*

The TL growth curve data were fitted by a saturating exponential and the equivalent dose was calculated by interpolation of the natural TL intensity.

All the samples were from within ridges and all are assumed to have been deposited under aeolian dune conditions. All three show good TL characteristics during the analysis and the dates are consistent with other TL dates for the aeolian calcarenites in coastal southwestern Victorian (Oyston, 1996)

The dunes appear, therefore, to have been deposited during the late mid Pleistocene and both sites exhibit extensive cave development. Nevertheless, the relationship of the caves to the current water table indicates that their major speleogenesis has occurred not under present-day water table conditions, but present-day modification of existing passages is occurring. The age of the dunes assists in establishing the time frame for speleogenesis in such calcarenite dunes and shows that such karstification occurred simultaneously with dune lithification.

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The samples for Codrington were analysed by Ben Oyston,1996 at Latrobe University and for Bats Ridge by David Price at Wollongong Thermoluminescence Dating Laboratory.

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References

AITKEN, M.J., 1985: *Thermoluminescence Dating*. Academic Press, London.

GRIMES, K.G., MOTT, K. & WHITE, S., 1999: The Gambier Karst Province *In:* HENDERSON K. [ed] *Cave and Karst Management in Australia* **13**, ACKMA, Carlton South : 1-7.

HUNTLEY, D.J., HUTTON J.T. & PRESCOTT, J.R., 1993a: The stranded beach-dune sequence of south-east South Australia: a test of thermoluminescence dating, 0-800 ka. *Quaternary Science Reviews* **12**: 1-20.

HUNTLEY, D.J., HUTTON J.T. & PRESCOTT, J.R., 1993b: Optical Dating using inclusions within quartz grains. *Geology* **21:** 1087-1090.

HUNTLEY, D.J., HUTTON J.T. & PRESCOTT, J.R., 1994: Further Thermoluminescence dates from the dune sequence in the southeast of South Australia. *Quaternary Science Reviews* **13**: 201-207.

IDNURM, M. AND COOK P.J., 1980: Palaeo-magnetism of beach ridges in South Australia and the Milankovitch theory of ice ages *Nature* **286**: 699-702.

SCHWEBEL, D.A., 1984: Quaternary Dune Systems *in* TYLER, M.J. TWIDALE, C.R., LING, J.K. & HOLMES, J.W. [eds] *Natural History of the South East*, Royal Society of South Australia Inc., Adelaide. pp 15-24

OYSTON, B., 1996:*Thermoluminescence dating of quartz from Quaternary aeolian sediments in Southeastern Australia*, Unpub. Ph D Thesis, LaTrobe University.

WHITE, S., 1994: Speleogenesis in aeolian calcarenite: A case study in Western Victoria. *Environmental Geology* **23**:248-255

REVIEWS

EVOLUTION OF CAVES AND THE INCEPTION HORIZON HYPOTHESIS

By Albert Goede

Review of a paper by **Osborne, R. A. 1999: The Inception Horizon Hypothesis in vertical to steeply-dipping limestone: applications in New South Wales, Australia. *Cave and Karst Science* 26(1), 5-12.**

The inception horizon hypothesis has been developed by Lowe (1992) and Lowe & Gunn (1997) in Britain to explain cave morphology in horizontal to gently-dipping limestones. Osborne has extended the concept to vertical or steeply-dipping limestones with special reference to the small impounded karsts of New South Wales. However, his ideas are useful in gaining a better understanding of cave morphology throughout the Eastern Highlands of Australia as well as Tasmania, wherever cave development has taken place in strongly folded carbonate rocks that are mostly of Palaeozoic age.

Lowe (1992) defines an inception horizon as "any lithostratigraphically controlled element of a carbonate sequence that passively or actively favours localised inception of dissolutional activity, by virtue of physical, lithological or chemical deviation from the predominant carbonate facies of the sequence".

Lowe and Gunn (1997) define four categories of inception horizons:

(1) Aquifuge, aquiclude, aquitard and aquifer horizons - usually clastic beds.
(2) Trans-bedding contrasts.
(3) Acid generating horizons
(4) Physically soluble horizons

Osborne makes the point that many such horizons will tend to be laterally discontinuous because of the nature of carbonate deposition. He applies the concepts developed by Lowe and Gunn to the large number of small Siluro-Devonian karst areas found within the Lachlan Fold Belt along the margins of the Eastern Highlands within New South Wales. Features of caves in these areas noted by the author are the degree of strike control on cave passage orientations, the occurrence of siliceous sedimentary fills and in many cases a close relationship with hydrothermal ore deposits. Palaeokarst deposits are common and some cave passages represent exhumed ancient relics. Associated surface features are vertical limestone cliffs, gorges, dry valleys and natural bridges.

In order to provide a comprehensive general theory, the author makes a number of simplifying assumptions but it must be kept in mind that these may not always be justified when studying the development of individual cave systems.

Evolution of caves is interpreted in terms of the geometry of interaction between inception horizons and structural weaknesses such as joints and their spatial geometry, especially the spacing between them.

Evolutionary patterns are related both to early phreatic stages of development and the progressive capture of surface streams. Since we are dealing with small impounded karsts, there is often a plentiful supply of clastic sediments derived from non-carbonate rocks at higher elevations that are characterised by surface drainage. This may lead to the blocking of underground pathways through the limestone resulting in a return to surface drainage and valley incision along the lateral boundaries of the limestone outcrop. The author points to widespread evidence of palaeokarst deposits in caves in eastern Australia and believes that such deposits are more likely to be found in vertical or steeply-dipping limestones than in horizontally-bedded or gently-dipping limestones because alternative laterally adjacent pathways may not be available.

The development of "keyhole" passages and paragenetic loops is explained in terms of the inception horizon hypothesis. Passage cross-sections that superficially resemble classical keyhole passages may have flat ceilings cutting across the bedding and are better explained in terms of paragenetic processes, i.e. the gradual infilling of passages by clastic sediment causing solutional planing and widening of the ceiling. Partial sediment blockages may also cause the development of paragenetic loops. An example is illustrated from River Cave at Jenolan.

Speleologists with an earth science background will find much of interest in this paper. While Osborne has concentrated his research in N.S.W., there is considerable scope to test the hypothesis in other parts of eastern Australia and in Tasmania by close examination and detailed mapping of caves in strongly-folded limestones. The author's claim that palaeokarst deposits are more commonly found in caves in steeply-dipping limestones rather than in horizontal or gently-dipping carbonate rocks also requires verification as it can be argued that his research of such deposits has been strongly biassed towards their occurrence in steeply-dipping limestones.

Although paragenetic processes are mentioned only in passing, their effect on cave evolution during the Quaternary period requires much further research as climatic changes during the Quaternary have been both frequent and dramatic. These effects should be more apparent in areas such as Tasmania and the South Island

of New Zealand where the climatic impacts are more dramatic due to the repeated impacts of glaciation and the higher relief of karst areas.

The paper is well presented with numerous informative diagrams. It should encourage further research on the evolution of caves in vertical or steeply-dipping carbonate rocks.

References

Lowe, D. J. 1992. The Origin of Limestone Caverns: An Inception Horizon Hypothesis. Unpublished PhD Thesis, Manchester Metropolitan University, 512pp.

Lowe, D. J. & Gunn, J. 1997. Carbonate speleogenesis: an inception horizon hypothesis. *Acta Carsologica*, 26(2), 457-488.

WHAT IS KARST? – A REVIEW

by Albert Goede

***Review of a paper by* DOERR, S. H. 1999: Karst-like landforms and hydrology in quartzites of the Venezuelan Guyana shield: Pseudokarst or "real" karst? *Zeitschrift fur Geomorphology* 43 (1), 1-17.**

The development of karst-like landforms on siliceous rocks such as quartzites and sandstones is of considerable interest to Australian geomorphologists as these landforms are relatively common in northern Australia (Jennings, 1983). Such landscapes are not usually regarded as true karst and their evolution has frequently been attributed to widening of tectonic joints and fissures by the weathering of cements (arenisation) causing quartz grains to become detached and allowing them to be removed by fluvial processes.

The paper deals with the quartzite landscape of the Venezuelan Gran Sabana which shows many karstic features and has the world's deepest cave system found in quartzite. The Gran Sabana is characterised by table mountains that rise to 2700 m and are composed of flat-lying quartzites, quartzose sandstones and quartz conglomerates belonging to the 1800 m thick Roraima Formation resting on a basement of igneous and metamorphic rocks that are older than 1.6 billion years. The table mountains cover an area of 200,000 km2 with the higher summits receiving an annual precipitation of 4000 - 7000 mm. The summit plateaus are partly covered by peat and the streamwater at the foot of the mountains is quite acid with an average pH of 4.0.

Karstic features that have been found in the area include karren, grikes, towers, sinkholes and uvalas. A number of cave systems is also known with the most extensive being Sima Aonda Superior Sud with a passage length of 2128 m and a depth of 360 m.

The word karst is normally reserved for landscapes where corrosion - removal by solution - is the dominant erosional process. This is usually the case with rocks such as limestone, dolomite and gypsum. Similar features in quartzitic rocks are commonly referred to as pseudokarst implying that other processes have been dominant. Karstification in such rocks is usually regarded as being due to arenisation - the dissolution of cementing material around individual quartz grains. Once loosened, the grains are washed away by running water creating underground passages by a process called piping.

The author has examined thin sections of quartzite from one of the smaller caves (Cueva Kukenan) and found that in fresh samples the quartz grains are locked together by crystalline overgrowths - not by amorphous cement. In weathered rock samples both the overgrowths and the quartz grains themselves show evidence of having been attacked by solution. Also in this cave, the presence of rock columns with circular cross-sections has been used as evidence of solution being the dominant cave forming process. If arenisation had been dominant, columns with elongated cross-sections would have been expected.

The author has argued that while the rate of silica solution may be slight, the superhumid environment, and the long period of time over which the plateau rocks have been exposed, has allowed the development of a true karst topography. The solution of silica, unlike that of carbonate minerals, is not influenced by the CO_2 content of the water. This means that the solution of silica is not necessarily enhanced by the presence of a soil and vegetation cover, an important factor in accelerating the solution of carbonate minerals. Since degassing of CO_2 plays an important role in the deposition of carbonate speleothems and as this process does not affect silica in solution it also helps to explain why quartzitic speleothems are rarely found.

The paper contains a number of photographs of karst features and thin sections, a map of the Cueva Kukenan cave system and several diagrams. It has a useful list of references that refer to karst development in siliceous rocks in other parts of the world - especially southern Africa and Australia.

References

Jennings, J. N. (1983). Sandstone Pseudokarst or Karst? In: Young, R. W. & Nanson, G. C. (Eds) Aspects of Australian Sandstone Landscapes. *Australian and New Zealand Geomorphology Group Special Publication* No. 1, 21-30.

NEWS and VIEWS

The Fifth Australian Karst Studies Seminar, Wellington Caves, NSW, February 2000

In February 2000 about 40 karst enthusiasts met at Wellington Caves for four days of talks, discussions and field trips for the fifth karst studies seminar. Previous seminars have been held at Buchan Victoria in 1992, Wombeyan, NSW in 1994; Naracoorte, SA in 1996 and Mole Creek, Tasmania in 1998. The overall theme of the conference was *Concepts in Karst Studies*. The abstracts will be included in the next issue of *Helictite*. A few enthusiasts also attended the **Quaternary Studies Meeting**, 7-9 February 2000 at ANU Canberra in honour of Prof. Jim Bowler, where a few karst papers were presented.

Speleological Abstracts 1999

A small band of abstracters is currently producing the Australian contribution to the International Speleological Abstracts. Covering the major speleo publications is straight forward but finding the more obscure material is more difficult. If you can assist please let Greg Middleton know at PO Box 416 Sandy Bay 7006.

Australian work has often been under represented in Speleological Abstracts in the past. Now we have a chance to rectify this.

AQUA

The Australasian Quaternary Association is an informal grouping of people interested in the range of phenomena of the Quaternary. It seeks to encourage research, promote scientific communication between Australia and New Zealand and inform members of recent research and publications. It holds biennial meetings and publishes the journal *Quaternary Australia* twice a year. The annual subscription is $25.00 ($15 students, unemployed, retired). Application forms can be obtained from Prof. Geoff Hope, ANH RSPacS, ANU Canberra ACT 0200 (phone (062) 493283; Fax (062) 494917; email geoff.hope@coombs.anu.edu.au).

Although AQUA has a much broader perspective than speleological issues, a great deal of interesting material in cave sediments, dating and palaeontology are to be found in Quaternary Australia and at the meetings. The next conference is at Port Fairy in February 2001.

FUTURE EVENTS

AQUA Biennial Conference, Port Fairy

Place: Port Fairy, Victoria, Australia.
Date: 5th – 9th February 2001
Contact: Dr. Simon Haberle, School of Geography and Environmental Science, Monash University, Clayton, Victoria, Australia
Tel: (03) 99052932, Fax: (03) 9905 2948
Email: Simon.Haberle@arts.monash.edu.au

9th Australian & New Zealand Geomorphology Group

Place: Wanaka, Central Otago, South Island, New Zealand.
Date: 11th – 15th December 2000
Conference Enquiries: Kirsten Hennrich, School of Earth Sciences, Victoria University Wellington, P.O. Box 600, Wellington, New Zealand
Email: Kirste.Hennrich@vuw.ac.nz
Web site: http://www.geo.vuw.ac.nz/conferences

23rd Biennial ASF Conference

Place: All Saints College, Bathurst, NSW.
Date: 28th December 2000 – 2nd January 2001
Organisation: Australasian Speleological Federation.
Contact: Jodie Shoobert, P.O. Box 15, Broadmeadows, NSW 2292. Fax: (02) 4926-1772
Email: rutco@bigpond.com
Conference Convenor: Angus Macoun, Tel: (02) 94162588
Email: artoflight@eisafree5.com.au
Web Site: http://www.rutco.com.au/asf/2001
Presentations or Workshops: Keir Vaughan-Taylor
Email: keir@ee.usyd.edu.au

Notes: Any offers of assistance would be appreciated. Please contact the Conference Convenor. The cost will be under $300.00 which will include everything. There will be a variety of post-conference trips including a surveying course, canyoning and caving at areas such as Cliefden, Jenolan, Wellington, Tuglow, Colong, Wombeyan, Wyanbene and Yarrangobilly.

14th Australasian Conference on Cave & Karst Management – ACKMA

Themes: Use and management of wild caves, karst rehabilitation, innovations in tourist cave management.
Place: Wombeyan, NSW, Australia.
Date: 29th April – 5th May 2001
Organisation: Australasian Cave & Karst Management Assoc.
Contact: Michael Chalker, Wombeyan Caves,
PO Box 18, Taralga, NSW, 2580.
Telephone: (02) 4843 5976, Fax: (02) 4843 5988.
email: wombeyan@goulburn.net.au

INTERNATIONAL NEWS

IUS Commission on Karst Hydrology And Speleology

This commission, chaired by Dr. Alexander Klimchouk (Ukraine), has as its theme karst hydrology with a special emphasis on the role of speleogenesis as a core problem in the development of karst aquifers. Details of commission activities can be accessed at http://happy.carrier.kiev.ua/~klim/UIS_KHS/. Similarly Karst Conduit – a joint IUS and IUG web-based newsletter can be accessed at

http://rubens.its.unimelb.edu.au/~pgm/uis/khs.html

Two publications , *Gypsum Karst of the World* (1997) and *Speleogenesis: Evolution of Karst Aquifers* (2000), have been produced. The latter, recently published by NSS, summarises recent advancements in speleogenesis theory and its relationship to the development of permeability and the evolution of karst aquifers.

The three current projects and their co-ordinators are:

- Karst Hydrology and Speleogenesis in Deep-seated and Confined Settings
  [Co-ordinators: Alexander Klimchouk and Yury Dublijansky]
- Epikarst: its nature, hydraulic functioning and the role in karst morphogenesis
  [Co-ordinator: John Gunn].
- Practical Implications of Speleogenetic Studies [Co-ordinator: John Lamont-Black]

In particular the project on the Practical Implications of Speleogenetic Studies aims to apply the concepts reviewed in *Speleogenesis: Evolution of Karst Aquifers* to practical problems involving karst and caves, in the context of useful case studies. As such, it hopes to illustrate how a deeper understanding of speleogenetic processes can be utilised and applied in the disciplines of engineering and mining geology, hydrology and geography to develop more robust and elegant solutions to practical problems associated with karst.

Details of these projects can be accessed from the web page.

INTERNATIONAL MEETINGS

13th UIS International Congress of Speleology

Place: Centro de Convencoes de Brasillia, Brazil.
Date: 1st July – 6th August 2001
Organisation: International Union of Speleology (IUS).
Contact: Jose Ayrton Labegalini.
Email: jal@sulminas.com.br
Website: http://www.speleobrazil2001.org.br/.
Notes: Pre-Congress: 1st – 14th July
Congress: 15th – 22nd July
Post-Congress: 23rd July – 1st August

Conference on Sustainable Development in Karst Regions

Place: Beijing, China.
Date: 24th – 27th August 2001
Organisation: The Geological Society of China.
Contact: Mr. Wang Wei, Miss Wang Yanjun, Geological Society of China, No. 26 Baiwanzhuang, Beijing, 100037, P.R. China.
Tel: +86 (10) 6831 1539 or 6831 1133 Ext. 2248. Fax +86 (10) 6831 1324.
Email: GACSDIC@public.bta.net.cn.

The main problems related to sustainable development in karst regions will be discussed at the conference. Before and after the conference four field trips will be organised to investigate typical karst regions and to visit related water power station, thermal springs, some tourist caves and treatment of karst geological hazards.

Universities of Franche-Comte and Neuchatel 7th conference on Limestone Hydrology and Fissured Media

Organised by the Research Team: Strain, Flow, Transfer in Besancon (France) and the Hydrogeology Centre of the University of Neuchâtel - CHYN (Switzerland)

Besancon 20th to 22nd September 2001
Details are available from Pr. Jacques MUDRY; EA Strain, Flow, Transfer; Faculty of Sciences,25030 BESANCON Cedex - FRANCE
Phone 33 3 8166 5753 Fax 33 3 8166 5794
jacques.mudry@univ-fcomte.fr

The Conference will concentrate on:

1. Data acquisition and underground measurements
2. Investigation and description of Epikarst
3. Numerical simulation of flow and transport processes
4. Dissolution and speleogenesis
5. Vulnerability of karst groundwater (definition and mapping)
6. Karst of the Jura massif (session dedicated to Pr. Pierre Chauve).

A one-day excursion in the karstic Jura massif is scheduled.

Information for Contributors to Helictite

Scope

Contributions from all fields of study related to speleology will be considered for publication. Suitable fields include Earth Sciences, Speleochemistry, Hydrology, Meteorology, Conservation, Biospeleology, History, Major Exploration (Expedition) Reports, Equipment and Techniques, Surveying and Cartography, Photography and Documentation. Comprehensive descriptive accounts of the exploration and morphology of individual caves will be welcomed, but simple trip reports and brief cave descriptions are not adequate. Papers overall should not exceed 20 printed pages in length. Contributors intending to write at greater length or requiring any advice on details of preparation are invited to correspond with the Editors. All manuscripts will be read by referees. "News and Views", "Short Notes" and "Letters to the Editor" , expressing a personal view or giving a preliminary report of interesting findings, are welcomed, and will be given preference for speedy publication.

Manuscripts

Submitted manuscripts should initially be in printed form. Manuscripts should be typed, double spaced, on one side of the paper. Do not use multiple columns - this manuscript is for the editors and referees use and does not have to look like the final production.

The title should be upper case bold and the author's names should follow. A brief and explicit summary of the notable aspects of the paper, headed abstract, should precede the main text. Acknowledgements should be placed at the end of the text before the references, and the author's addresses for correspondence should follow the references.

Authors are requested to submit a copy of their final manuscript by email or on floppy disk as well as hard copy. Disks may be 3 ½" or 5 ¼" in either IBM or Macintosh format. If sending text as a word processing document (Microsoft Word etc.), please also send a copy as plain text on the same disk. Separate instructions concerning electronic layout are available.

References

References should be listed alphabetically at the end of the manuscript and cited in the text by the author's name and the year of publication (e.g. "(Grey, 1973)") Where there is more than one reference to the same author in one year the letters a, b, c, etc. should be added. If there are more than two authors, they should all be named at the first citation and in the reference list, but the first name followed by et al. should be used in subsequent citations. References should be checked particularly carefully for accuracy. Journal titles should be abbreviated following the "World List of Scientific Periodicals", which is available in most large libraries.

The following examples illustrate the style:

GREY, M.R., 1973 Cavernicolous spiders from the Nullarbor Plain and south-west Australia. *J. Aust. ent. Soc.* **12:** 207-221.

VANDEL, A., 1965 *Biospeleology. The Biology of the Cavernicolous Animals.* Pergamon, London. Pp. xxiv, 524.

WIGLEY, T.M.L. and WOOD, I.D., 1967 Meteorology of the Nullarbor Plain Caves. *In:* J.R. DUNKLEY and T.M.L. WIGLEY (eds), *Caves of the Nullarbor. A Review of Speleological Investigations in the Nullarbor Plain, Southern Australia*: 32-34. Speleological Research Council, Sydney.

Illustrations

Figures and photographs should not duplicate information in tables or other material. Photographs should be clear black and white prints with sharp focus. The number of pages with photographs will be kept to a minimum. Any lettering required on photographs should be applied with "Letraset". Figures should be drawn in Indian ink on white card, heavy paper or tracing material and lettered using stencils or "Letraset" or supplied as Laser prints. Ink-jet prints should be enclosed in plastic to reduce the risk of water damage in transit. Most computer drawn documents and photographic images can also be handled. Please ask for additional instructions on file formats, pixel widths and photo "enhancements".

All illustrations should be drawn to fit within a full page print area of 170 x 258 mm and ideally should be a column width (80mm) or double-column width (170 mm). They may be supplied larger provided that these proportions are maintained, but allowance for reduction must be made when choosing letter sizes and line thickness.

Figures and plates should be numbered in a single sequence and specifically referred to in the text. The numbers should be marked lightly in pencil on the margin or back of each illustration. An arrow and the word "top" should be used if orientation is not obvious. Captions should be typed on a separate sheet (or supplied at the end of the text file).

Units

The S.I. system (Australian Standard AS 1000) should be used unless citing historical data, in which case the original units should be quoted and appropriately rounded metric equivalents added; 100 feet (30 m)

Offprints

Twenty free offprints of papers will be supplied after publication. Additional offprints can be arranged at the author's expense. The number required should be stated when submitting the final manuscript.

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