SINKHOLES OF THE LOWER SOUTH EAST OF SOUTH AUSTRALIA

Underwater Environments & Life Forms

by

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Until recently, very little research had been undertaken regarding underwater life-forms in the caves, although some of the popular streams and ponds have been thoroughly studied by qualified people in recent years.

Initially spurred more by curiosity than a feeling of obligation to science, the author, assisted by his cave-diving companions, decided to observe and attempt to document the sinkhole environments and creatures so that at least some basic information existed.

A three-monthly study of water temperature profiles in four selected sinkholes brought out some interesting and, for the cave-diving community, potentially useful facts, and discoveries of relatively rare creatures of significant scientific value were made during the first year of research.

The work is now being undertaken in conjunction with members of the scientific community and it is hoped that the findings presented here will be of interest to all conservation-minded cave-divers and researchers involved in speleological studies.

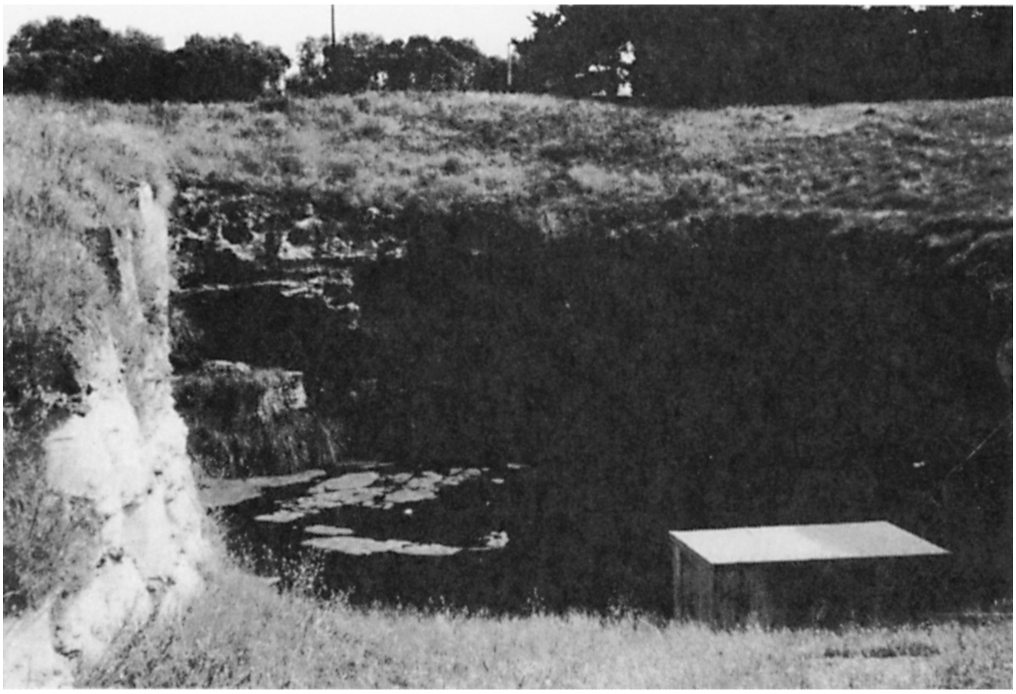
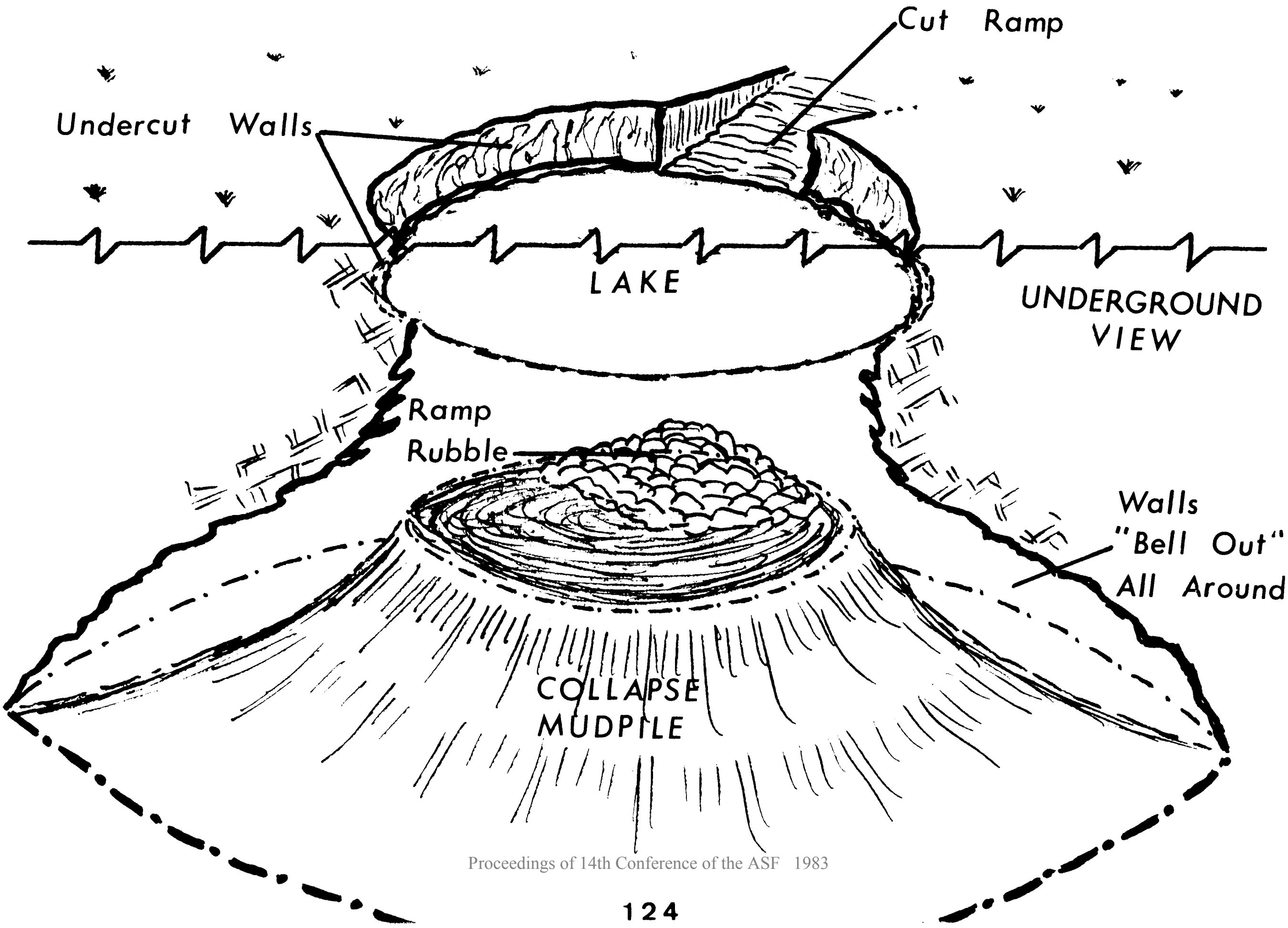


FIGURE 1: "GOULDEN'S WATERHOLE", A SINKHOLE WITH A MAN-MADE RAMP CUT DOWN TO THE WATER TO ASSIST STOCK

photo: Peter Horne

FIGURE 2: 3-D SKETCH OF A "TYPICAL" SINKHOLE



INTRODUCTION

The Lower South East of South Australia has long been known as a major cave-formation area, and was consequently one of the most popular regions visited by people with speleological interests. However, only since the local divers first began to explore their waterfilled caves with Scuba in the early 1960s, has the importance of the underwater sections been realised. The clean, fresh water, filtered through many kilometres of limestone is of a very high quality and an exhilarating experience to explore.

Since those early days, thousands of people have shared their feelings by diving in those caves, and considerable work has been accomplished by several individuals and Universities regarding the identification of the aquatic life which inhabits the coastal springs known as Ewens and Piccaninnie Ponds. This research brought to the public's attention the value in preserving such regions as they contain relatively rare and unique creatures and waterplants, but to our knowledge, no such research has been undertaken in this vein, in the true sinkholes and caves of the Mount Gambier region.

Although most divers are aware of some forms of life in the sinkholes, none had ever bothered to collect specimens for the South Australian Museum for study or identification. Much of the collecting work had been done by a local CEGSA member, Fred Aslin, who is not a diver, and it was mainly as a result of our discussions with Fred that our group decided to try to collect some individual specimens.

Within a few days after our discussions with Fred, in January 1981, our diving party collected some small, centipede-like creatures which were seen swimming about in a small cave known as Fossil Cave, or the Green Waterhole, near Tantanoola. They were taken to the South Australian Museum and the University of Adelaide for study. Their discovery was found to be very significant because the creatures had never been recorded before, and similar species are rare. (See Fig. 8).

Our group was loaded with enthusiastic questions about the life-forms and the sinkholes, but there appeared to be no informed source we could approach to obtain satisfactory answers. It became evident that there were few experts in this field as so little research had been done. The only maps which existed of the sinkholes so popular for cave divers were those drawn up by Peter Stace and Ian Lewis and friends, in the course of their writing of the book "Cave Diving in Australia". Thus, we decided to undertake a layman's project involving the collection of information about the sinkholes of the region.

GENERAL ASPECTS OF THE SINKHOLES

It is important to consider all the features of these caves if we are to better understand the underwater environment, and the range and density of life-forms which can be found there.

Most of the larger waterfilled sinkholes, or "Cenotes", are generally circular in shape and between 20 and 40 metres in diameter, with undercut walls of around 8 to 10m in depth to the water. Many sinkholes, like Goulden's Waterhole (Fig. 1) have ramps which were made into one wall so that stock could reach the water, and often water is pumped for irrigation. Others, such as The Black Hole or Devil's Punchbowl, are almost as natural today as when they were found in the 1840s, requiring a length of rope or cable ladder to reach the ledges above the water. The most extreme example of this kind of sinkhole is Hells Hole which is a 20-odd metre ladder descent directly into 5m deep water. Many smaller caves have a variety of methods of entry.

MAIN UNDERWATER FEATURES

The large cave opening visible at the surface is merely a "window" to the vast caverns which lie under water. Whilst caves meander along randomly orientated joints and cracks, most main tunnels in this region run roughly north-west/south-east and even the big cenotes tend to have their deepest sections and longest penetrations along these directions. Sinkholes generally consist of a large-diameter collapse which fell into a large open cavern. They look something like a champagne glass tipped upside-down, or a bell. (Fig. 2). Lying directly below the entrance is a large rockpile collapse, and although no two sinkholes are exactly the same shape underwater, they generally follow the same basic pattern.

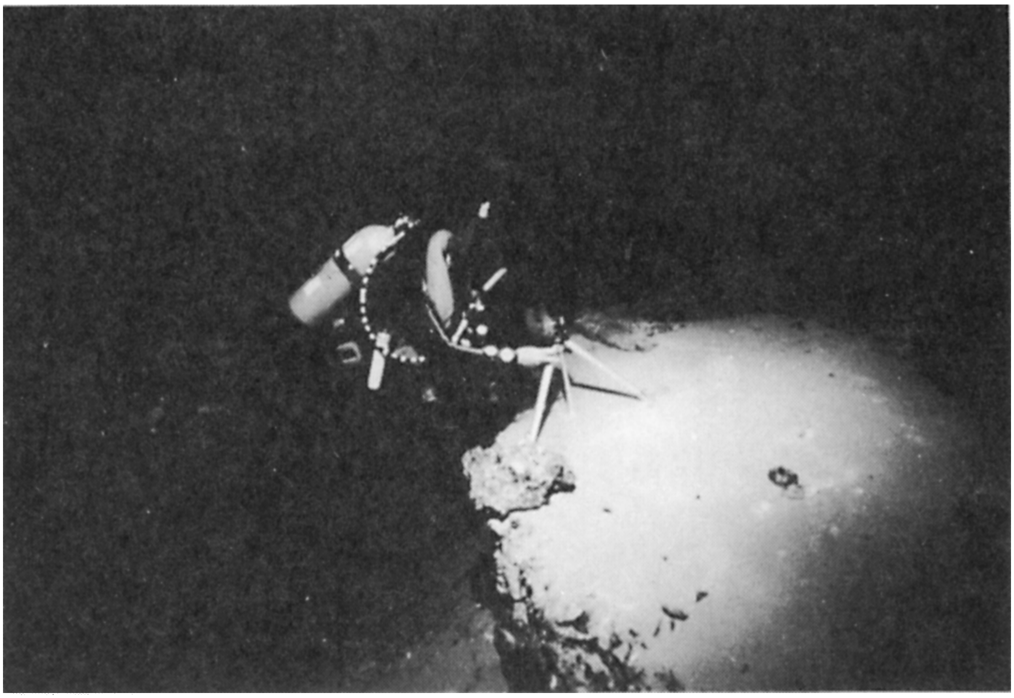
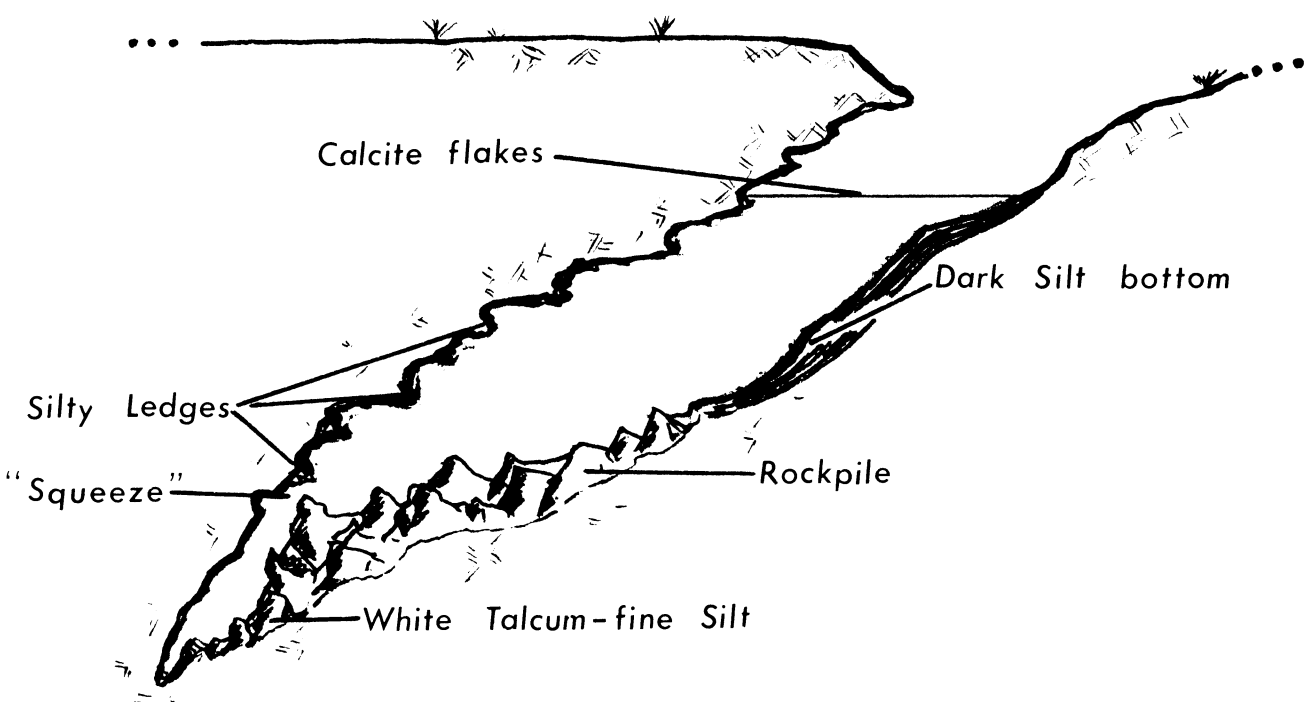


FIGURE 3: A DIVER TAKES PHOTOGRAPHS AT 36m IN THE CLEAR, DARK CAVERN OF L47- "THE BLACK HOLE".

photo: Peter Thompson

FIGURE 4: FEATURES OF A SMALL WATERFILLED CAVE



Most of the larger sinkholes contain water at depth which is indescribably clear (Fig. 3). The huge limestone boulders, some as big as trucks, stand out sharply on the bottom, often covered in a layer of smooth silt which lies like a plain of concrete visible for as far as the shape of the circular sinkhole will allow. This silt is extremely soft but quite thick - a real hazard in confined sections of the caves and a potential killer if guidelines are not used by divers. The silt is one of the reasons for the clarity of the water - the tiny calcite particles attract the washed-in clay particles and then settle to the bottom. The result after many thousands of years is the silt we see today.

Not all sinkholes look the same on the bottom, however. Hells Hole, for example, has a mass of submerged trees lying on the central sandpile, and a discarded car which was deliberately driven over the edge of the hole. Many other sinkholes have car bodies in them as well as rubbish of every description.

The Cave Divers Association of Australia's Category 3 type caves (Fig. 4) are generally more of a true cave than a sinkhole, containing cold, generally clear water which remains about the same temperature throughout the year. Undisturbed caves often have fine flakes of calcite floating on the surface and sheets of this material are deposited over the bottom, along with the silt. This is calcite which has come out of solution.

Whereas the larger sinkholes seem to have relatively smooth walls, the smaller caves often have shelves sticking out from the ceilings, which are covered in thick layers of fine silt. They also have delicate limestone features such as soft walls with etched holes through them and the ceilings themselves are often so soft that large particles and slabs supported by the water sometimes become dislodged by the movement of divers' exhaust bubbles. Unfortunately, the age-old problem of graffiti is now as bad underwater as it is in many of the dry caves, but hopefully people are becoming more conservative as they become educated about what the sinkholes really are.

THE UNDERWATER ENVIRONMENTS

The underwater conditions are evidently very dependent on the time of year and the weather. Although people generally hear that the water in the sinkholes is "crystal clear", this impression is generally false. With only a few exceptions, the clearest water is at the bottom of the caves, where there is also very little, if any, daylight. Water temperature and exposure to sunlight would appear to be major influencing factors in water clarity. During 1981, our group conducted a three-month study of the environment in four popular sinkholes, taking temperature readings and visibility estimates at 3m intervals in depth. It was unfortunate that 1981's winter proved to be one of the wettest on record, and the extreme inflow of water, which raised the levels in some caves by over a metre in a few weeks, probably had a major bearing on both the temperature and visibility. Nevertheless, the observed results were similar to what we had seen before actual measurements were made. Calibrated thermometers were borrowed from the Mt. Gambier office of the Engineering and Water Supply Department of South Australia.

A side-elevation view through Wurwurlooloo or One Tree Sinkhole (Fig. 5) shows in a very summarised form the main results of our preliminary study. In the warm summer months, the upper layer of water was warm, around 21°C, and murky, in the vicinity of 3-5 metres maximum visibility. This effect was evident in all four holes observed, although not the case in caves which were almost always in shadow.

As we went deeper, we encountered a sudden temperature drop, in the vicinity of 3-4° C, where the water appeared to become somewhat clearer, but darker, as the upper, green layer absorbed a lot of sunlight. Descending further, other cold zones, entered across thermoclines, sudden temperature changes were encountered, although none were quite as severe as the first, and the visibility continued to improve. By the time we reached the rim of the mudpile at 34 metres, we could see right around the sinkhole, although it took several minutes for our eyes to become 'night adjusted', as it was about as dark as a full-moon night. Although the dive is cold, the clarity is excellent and any decompression requirements are carried out in comfortably warm surface water, above the thermoclines.

In winter, however, the opposite appears to be the case. The water is cold even on the surface, but it looks more inviting because the murky surface water is absent, giving observers a clear

FIGURE 5: L7 ENVIRONMENT PROFILES

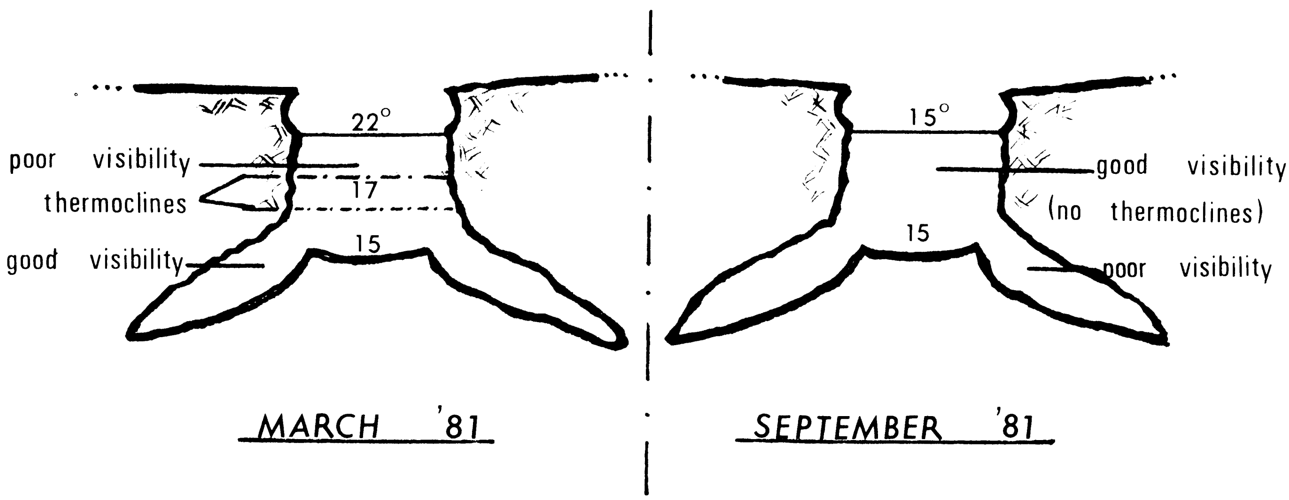
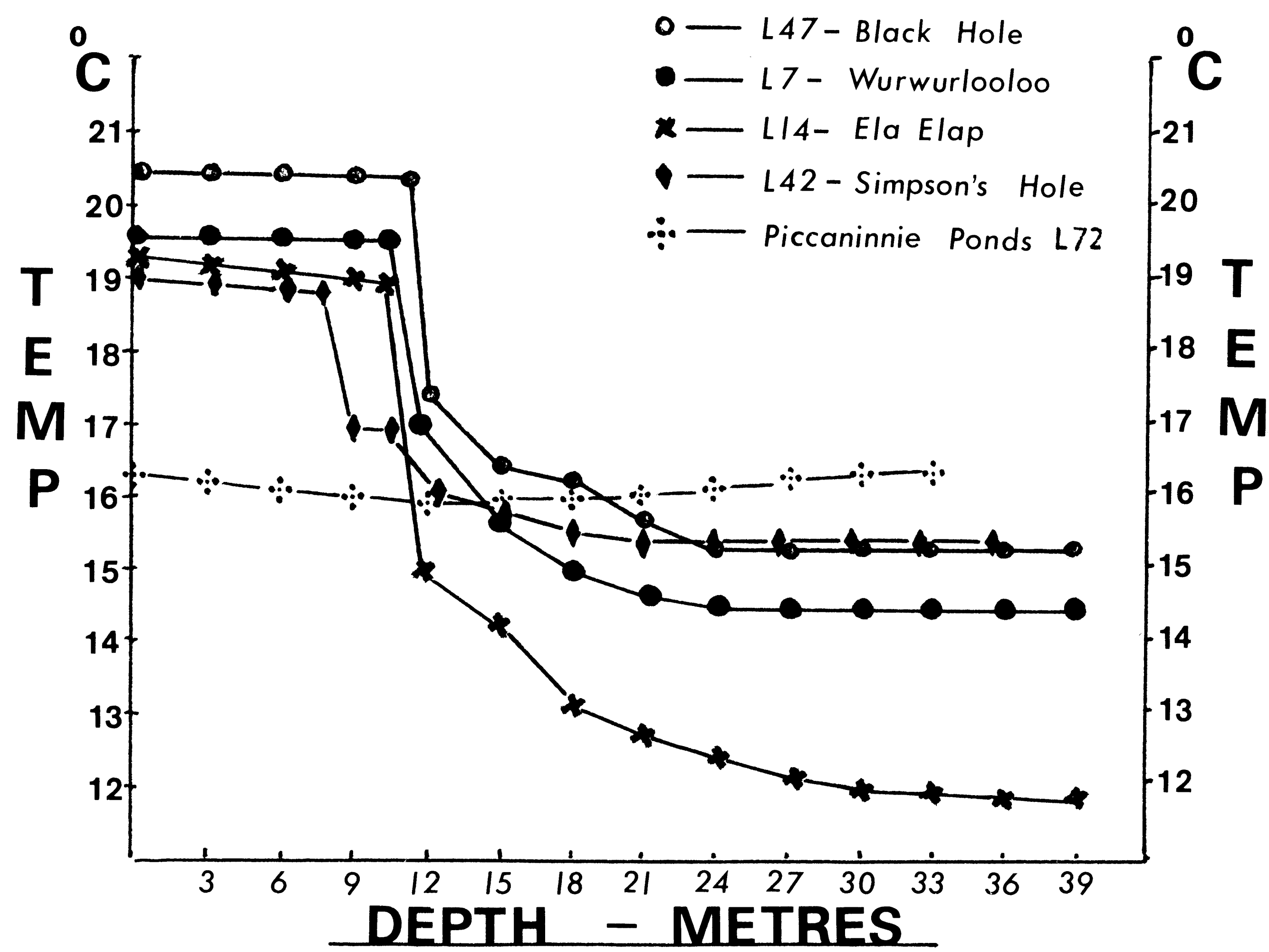


FIGURE 6: TEMPERATURES - MARCH '81



view to considerable depth. However, upon entering the water, and descending, no thermoclines are encountered and the visibility begins to deteriorate, to less than 1m at 38m. Added to this poor visibility are the factors of Nitrogen Narcosis, and cold, which, as those who have been there will truly know, is an experience well worth missing! Also, as there is no warm layer near the surface, decompression is very uncomfortable, and the final emergence into the more than likely typical South East winter storm is quite indescribable!

The results of the study are too detailed to go into here, but as Figure 6 shows, the surface summer readings were generally stable down to the thermocline, where the temperature plunged suddenly. Piccaninnie Ponds was around a constant 16^{o}C being a spring system. Ela Elap was an oddity, continuing to get colder to a recorded 11.2 ^{o} C minimum well after the other holes stabilised at the ground-water temperature of around 15^{o} C. In Jenolan and Tasmanian caves it would be about 5^{o} C colder. I would also like to briefly mention the peculiar effect we observed whilst passing through some thermoclines; the mixing caused between the warm surface water and the colder denser water produced visual effects like oil mixed in water. Nitrate samples were taken. The highest readings were in Allendale Sinkhole, at about 16 parts/million, which is about half of the Australian health limit of 30ppm. More details are available if anyone should require them.

LIFE IN THE SINKHOLES

Now that you've heard of the somewhat unpleasant and unusual conditions to be found in many of the sinkholes, you might understand why there hasn't been much interest shown in their potential for rare forms of life. Perhaps the first sign of life noticed by casual observers is the amount of plant growth around the water's edge. Thick reed beds make entry difficult in some holes, and a casual brush through them with unprotected arms can often elicit a yell of pain from the victim, who will find painful welts developing. Examination of the rushes will show the presence of an innocent-looking green plant which to the educated eye is called a cosmopolitan stinging nettle. I don't think its scientific name of 'Urtica incisa' comes from the fact that it's an Incisa that 'Urts, although one might think that even botanists have a sense of humour!

Often, free-swimming fish are seen flitting about under large floating algal mats, (Fig. 7), and those which have been caught have been either Native Trout or introduced Redfin Perch. The trout have modified their reproductive cycles to that of an enclosed system, instead of returning to the sea along streams and creeks. The Redfin can grow to well over 20cm and have been seen in the deepest levels of the sinkholes, but only about 4 holes have them to our knowledge.

Most sinkholes are inhabited by yabbies, and several species have been found. Wolfgang Zeidler, Curator of Marine Invertebrates at the South Australian Museum, is currently working on them, as well as the rare centipede-like creature mentioned earlier. A relative of the yabbie, the Freshwater Crayfish, has only been found in two true sinkholes, which lie near the Piccannie Ponds swamp. These holes are also the home of the only known sinkhole-inhabitating eels. As these eels, some well over 1½m in length are thought to reproduce only by returning to the sea, those individuals in the sinkholes are thought to be trapped there, after wandering around from the swamps on rainy nights. They probably feed on the resident trout and shrimps. Occasionally, Tiger Snakes are seen swimming across the surface of the sinkholes, especially in summer, and they are even thought to be able to dive to the bottom and hold their breath for some time. Divers please bear this in mind before touching any striped eels!

Descending once again to the gloomy, twilight world at the bottom of the sinkholes, small snails and pea-mussels can sometimes be found scavenging amongst the fossil shells of their ancient relatives. Tiny red worms are sometimes seen sticking their feeding filters out of the darker sediment, and many species of insect larvae, including the cricket-like may-fly nymph, are seen at various depths. The may-fly larvae are even to be found at 40 metres, but how they calculate decompression is anyone's guess.

Even the deepest and darkest sections of the mighty Black Hole and its nearby sister, Ten Eighty or Simpson's Hole house forms of life unique to these locations. The bright white gleam of tiny rose-like, freshwater sponges seen against the dark limestone boulders are a strange sight in the world of Nitrogen Narcosis and vast chambers (Fig. 8). These sponges living in total darkness

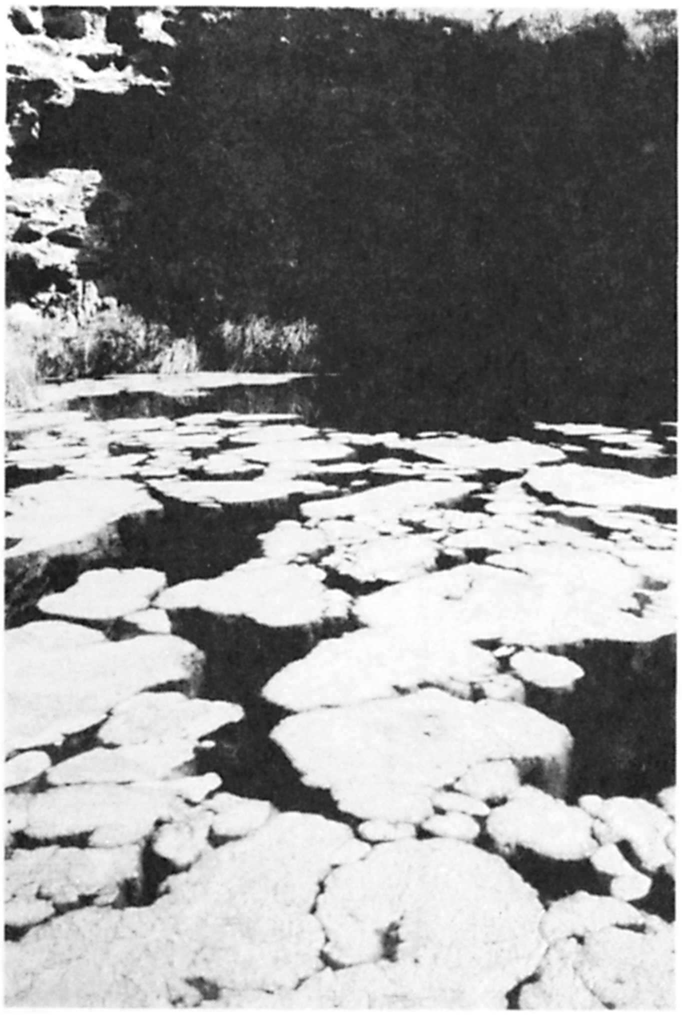


photo: Peter Horne

FIGURE 7: SIGNS OF LIFE IN A SINKHOLE - FLOATING ALGAL MATS

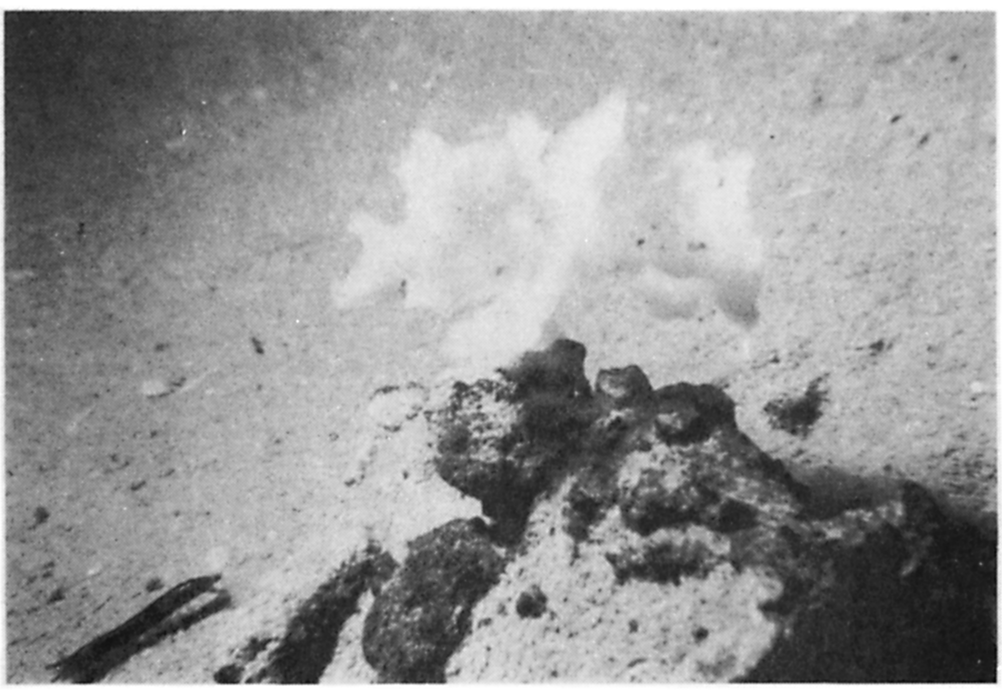


FIGURE 8: TWO RARE CREATURES AT 36m - A SPONGE AND A SYNCARID (BOTTOM LEFT)

photo: Jenny Ploenges

are currently unidentified and will possibly remain that way for some time. Dr. Keith Walker of the University of Adelaide is studying them. Even their means of reproduction has not been ascertained due to their lack of the normal cells. They can evidently reproduce from broken sections, but we doubt that they have evolved to become reliant on the clumsy kicking of cave divers' fins for reproduction! The white colour is replaced by a deep green at different times of the year, and this is thought to be caused by the presence of algae. Tiny snails also live on the sponges at these times.

Rare creatures like centipedes (see Fig. 8) are to be found at these depths as well, but only in a few sinkholes. Known as "Syncarids", these very primitive crustacea were previously thought to be found only as fossil specimens until the 1890s when the first living related species was found in Tasmania. Another species was found in the 1920s in Victoria, but our species, never before described, is as wide as the Victorian species is long; that is, about 5mm wide and over 20mm long. This new species lives permanently in the water, at all depths and is blind unlike all the others. They are evidently the only living common ancestor to the insects and crustacea.

Heading back towards our world of air, laden with samples and specimens, our divers might find flatworms living in the algaes and waterplants which lie on the shallow mudpiles. Beating off 5-centimetre-long leeches whilst decompressing is also very entertaining!

CONCLUSIONS AND ACKNOWLEDGEMENTS

I've tried to present, in a very short time, a resumé of our preliminary research into the sinkholes of the Mount Gambier region. There are probably many other creatures and features awaiting discovery and study if only the right people can become involved. I sincerely hope that this discussion paper has been of some interest and value in promoting the conservation of these unique features. I would like to thank all those people who have been of specific assistance over the past three years. I'd also like to especially thank Dr. Keith Walker, of the Zoology Department at the University of Adelaide for his exceptional interest, and my fellow cave-diving companions, especially Mark Nielsen and Jenny Ploenges, whose photographic skills presented with this paper speak for themselves.

PRESENTATION OF LIMESTONE GROWTHS FROM SINKHOLES

Several stromatolite-like rock growths were presented for comment. They are found on the sinkhole walls below water level and are not thought to be erosional in origin. They have internal structure and always "point" up towards daylight. In external form they look like leaning stalagmites up to 8m tall.

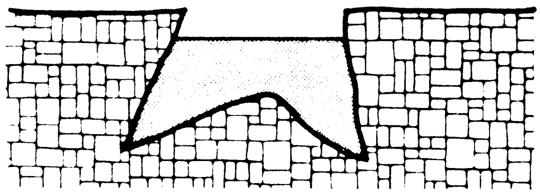
It should be noted that the water is of low salinity - about 300 milliequivalents per litre.

They might be dateable and, therefore, indicate a minimum age for the creation of the daylight openings, old water levels and other information.

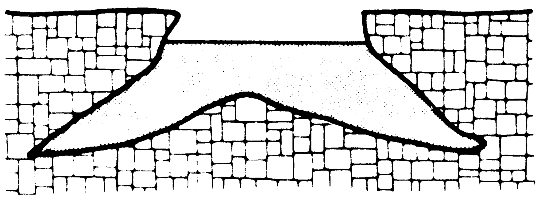
The CDAA "CATEGORY" SYSTEM

All the popular and well-known cave diving sites around the Mount Gambier area have been assessed by the CDAA and divided into 3 Categories, defined as:

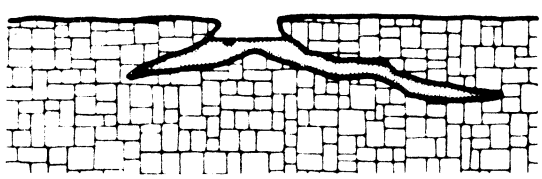
CATEGORY 1 . . . . Open sinkholes with no submerged passages.



CATEGORY 2 . . . . Sinkholes with submerged passages leading off.



CATEGORY 3 . . . . Sinkholes and caves with submerged passages and silting conditions.



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