THE IMPORTANCE OF CAVES AT YANCHEP, WESTERN AUSTRALIA,
WITH A COMMENT ON CAVE RESEARCH.

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Abstract; Adventurers, explorers, and people with interest in the outdoors - speleologists fit admirably into all these categories - typically find especial excitement in remote places. Equally valid is the adage that many points of interest lie close to home. So it is with our brief story today.

Yanchep National Park is only 50km from Perth, about an hour's drive north of the city centre. Its close proximity to a major urban environment forms part of the reason for our interest in the area. Nevertheless, it is appropriate to begin this account with a description of the caves at Yanchep. The Australian Karst Index (Matthews, 1985) lists 80 caves at Yanchep, although based on current knowledge the list is far from complete. Speleologists acquainted with the area have been forecasting over quite a few years that many more caves remain to be discovered and we gather these predictions are indeed being realized. Clearly, Matthews' excellent compilation is ready to be updated! The Yanchep caves occur in an aeolian calcarenite called Tamala limestone. Playford (1983) suggested that on Rottnest Island the oldest Tamala sediments date from the times of the Riss Glaciation (Pleistocene), and the youngest from the Flandarian (Holocene) transgression. However, the Tamala limestone is strongly diachronous throughout its extent (Wyrwoll and King, 1984) and thus it is not easy to correlate simply the age of Tamala limestone at Yanchep with the age of the Rottnest samples.

Cavern formation in aeolian limestone is of interest because the genesis is concurrent with lithification of the dune fabrics (Bastian, 1964; Jennings, 1968) as opposed to the long hiatus between deposition of limestone underwater with cavern formation occurring a long while later, following emergence. There seems to be general agreement concerning the primary importance of hydrological control over speleogenesis and cave morphology in Tamala limestone (Bastian, 1964; Jennings, 1968; Williamson and Lance, 1979). Bastian (1964) describes two cave morphologies, linear and inclined fissure. Both types occur at Yanchep, and consequently it is a good area for studies of the processes of syngenetic cave formation. Linear caves have domed roofs and are formed along well defined epiphreatic streams that are not easily diverted from their courses. Cave enlargement progresses predominantly through roof collapse; rubble from roof collapse quickly disappears - apparently dissolved by the stream water. A good example of such a cave is Cabaret (YN 5). Inclined fissure caves, which form in more coherent and stronger limestone than do linear caves, have the roof and floor surfaces nearly parallel. A good example at Yanchep is the deeper section of Carpark cave (not listed in Matthews, 1985).

This fairly long preamble highlighting the structural aspects of the Yanchep caves, has brought us now to our focus of interest - the groundwater streams which, according to Allen (1981), coincide with the zone of contact between sand and limestone where changes of transmissivity result in steep gradients of the water table. These epiphreatic streams are in fact the surface of the water table of the Gnangara Mound. More strictly, however, it is the tree rootlets growing along the margins of the cave streams which have captured our attention. Due to the fine branching and compact structure of these tree rootlets we have coined the term 'root mats' for them. The root mats are not found in all the Yanchep caves with water. In Mambibby (YN 12), for example, there are no root mats in any of the three pools, and in Crystal Cave (YN 1) there is but one small root mat. In Cabaret cave (YN 5), on the other hand, the root mats are well developed along both sides of the stream; this is the place where our studies are being conducted.

As has been frequently observed, caves lack a source of primary production, and so the animals which do inhabit caves rely upon sporadic inputs of organic carbon such as: guano, cadavas or plant debris. At Yanchep the caves are sufficiently shallow for tree roots to reach the subterranean conduits of the Gnangara Mound.

The stream in Cabaret Cave lies at 11m AHD and about 8m underground. The cavern is of the linear type and measures 25 m in length. About a quarter of the total length of stream margin is lined with root mats which can only belong to the tuart trees (*Eucalyptus gomphocephala*) growing above. Our studies have developed from two basic questions arising from the idea that the root mats provide a potentially utilizable source of primary production:-

(a) Do animals utilize the root mats as a food source?
(b) If so, how? - by direct feeding upon the root mats, or through a bacterial/fungal intermediate step?

We have cheated a little, because we have long since known that these root mats are home to a number of different animals. In 1980, one of us (B.K.) in collaboration with Chris Austin (then a PhD student), found a new species of janirid isopod and several other kinds of microscopic animals to be abundant in the root mats. Subsequently, Jim Burt undertook an Honours study focussing on the ecology of the Yanchep caves, and the biological adaptations to the stygian realms shown by a couple of the cave amphipods! He (Burt, 1982) lists 15 species of aquatic cavernicoles (which includes four accidentals) from Cabaret Cave. Our species list has been now increased to 25. Culver (1976) cites 3 to 5 species of crustaceans from caves in America as the norm and even then, none are abundant. We will discuss the significance of this fauna when our results are formally published, but there are two species worth special mention here: the amphipod *Austrochiltonia subtenuis* and the gilgie *Cherax quinquecarinatus*. Both species occur in reasonably large numbers in Cabaret Cave and also in nearby surface waters of Loch McNess. Compared with surface water populations, the animals from Cabaret Cave display the classical features of cave adapted animals.e.g. eye-pigment reduction, lower egg number and increased egg size in *A. subtenuis*, (Burt, 1982) and reduced body pigmentation in *C. quinquecarinatus*, (Muir, 1983). Yet Austin (pers. comm.) was not able to detect any genetic separation between surface and subterranean populations of both species using gel electrophoresis techniques. Here, therefore, is an ideal opportunity to investigate the vexatious issue of regression in respect of adaptation to caves, using conspecifics at the surface waters and in the cave. There are few places known where this opportunity occurs; commonly the relationships are at the generic level of similar forms of animals where subterranean and surface populations are close to each other. But, before a useful assault on the issue of regression can be made, it is essential to have conspecific populations in both surface and subterranean environments.

To return to the second question: are the primary consumer animals feeding directly on the root mats, or on bacteria/fungi living on root exudates? We have cheated here, also, in that our studies, which began in January 1990 have concentrated on the structure and function of the root mat. (We plan to begin researching this second question directly next year). At the time of writing this report, the studies are still in progress, and data from our monitoring programme will be provided at the conference upon completion of the first stage of the project.

Having outlined our scientific interest in the Yanchep caves, we will return to a comment made near the beginning of this talk, that part of our interest in the area lies in its close vicinity to Perth. Perth is a rapidly expanding urban centre, and humans require water. The Gnangara Mound is a large reservoir of ground water which can be tapped to help supply some of the increasing demands for water for the expanding population of Perth. The Water Authority of Western Australia (WAWA) has plans to construct three schemes for extracting water from the Gnangara Mound in the near future, and the Yeal scheme is the one likely to have an impact on the Yanchep caves area. The cave streams are very shallow (on average 3cm in depth) and we have no experimental knowledge on how resilient the root mat ecosystems might be to rapidly fluctuating water table levels in the caves. Would one season of no flow be sufficient to sound the death knell of these ecosystems? WAWA plans to restrict changes in the water table at Loch McNess to 0.5m or less (Environmental Protection Authority, 1987), but changes of such magnitude might still translate to unacceptable changes of water levels in the caves. We acknowledge fully that the personnel from WAWA responsible for developing the Yeal and other Gnangara Mound schemes are aware of the scientific value of the Yanchep caves and of the root mat ecosystems, and are taking a responsible attitude to conservation in the area. Nevertheless there is a potential conflict of interest and the situation should be carefully monitored before, during and after the construction of all the Gnangara Mound schemes.

This paper has highlighted the scientific interest in the aquatic ecosystems in the Yanchep caves. The Yanchep caves have also been important for Science in other respects. Archer (1972), Balme *et al.* (1978) and Merrilees (1968, 1979) have highlighted the paleontological value of the cave area with discoveries of skeletal remains of the Giant Kangaroo (*Sthenurus brownei*), wombat (*Vombatus* sp), Tasmanian devil (*Sarcophilus harrisi*), Koala (*Phascolasctos* sp) being notable finds. Indeed, Bettong (YN 51), Thylacine (YN 52) and Sarcophilus (YN 53) caves are listed in the *Australian Karst Index 1985* (Matthews, 1985) as paleontologically important sites. Caves have significance for a number of other scientific reasons - geological, geomorphological and anthropological. The 35 million Chinese who still live in caves can't be wrong! [as pointed out by Paul Theroux (p.65) in his recent travel book "Riding the Iron Rooster]. Theroux continues "There is no government programme to remove these troglodytes, and put them into tenements, but there is a scheme to give them better caves". The Australian Aborigine is not so fortunate, because the caves at Yanchep were home to the dreaded Waugul (Scott in Gentilli, 1963; Bridge, 1963) and this fact probably explains the dearth of aboriginal artefacts in the area, but what veracity lies in the legend of 16 battered female aboriginal skeletons found in Yonderup Cave (YN 2)? If true, this is surely evidence of an atrocity which should be researched.

The point is that caves are important for scientific and cultural reasons. They are recognized as an integral component of the National Estate (Committee of Inquiry into National Estate, 1974). They are being subjected increasingly to change, deliberately by vandalism, or by planned economic development, and also, as Norm Poulter highlights at this Conference, even as an inadvertent byproduct of caving. Study of caves proceeds haphazardly. In part that is as it should be, but it is time to raise the level of research activity concerning cave environments before important cave attributes and biota are irretrievably lost. Good research can proceed efficiently and quickly through well supervised PhD studies, and the speleological fraternity would help itself and also help achieve some of its objectives by working to establish a Commonwealth Government funded postgraduate scholarship. Speleologists should lobby, through their organisations for a scholarship to be awarded each year for postgraduate studies in any aspect of cave science to be administered through the Commonwealth Department of The Arts, Sport, The Environment, Tourism and Territories. Now is an excellent time for mounting such an exercise. The scholarship should be advertised Australia-wide to attract the most outstanding candidate from a wide variety of disciplines in each year. Such a scholarship would increase the pace of scientific research into basic speleological issues. In the late Prof. Jennings, there is an obvious and worthy choice of title for this kind of a scholarship.

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