CAVES: CHANGING ECOSYSTEMS?

(Some words in this article may be unfamiliar to the non-specialist reader. All words shown in italics, other than latin names of animals, are defined in the glossary at the end. Editor)

PERHAPS because cave biology appears to be of little but academic interest, the active biospeleologist is a rare animal and those who are working in the field are often as much concerned with compiling species lists and counting populations, as in investigating ecological interactions. Roberts (1974) suggests that the simpler an ecosystem (that is, the fewer species in that habitat) the more vulnerable will that system be to change. Diversity is thought to beget stability. The limited food that is available in the *abiotic* cavernous world can support only a sparse fauna, and it would be a great pity if any of these unique species were destroyed before we even knew of their existence. We should be aware of the fact that even quite small changes in a cave could lead to drastic changes in its *endemic* fauna. The causes of some possible man-induced changes are outlined in figure 32.

During the last few years the attention of some ecologists has been directed towards problems of *cultural eutrophication* in aquatic ecosystems. *Eutrophication* merely means enrichment of (or an addition of a surfeit of food to) a biological system and often happens naturally. Indeed if this did not happen, little or no life would survive underground. The enrichment of the cave environment by inputs of flood debris, animal droppings and similar *allochthonous* material is essential. In some caves, particularly in the tropics, animal breeding cycles are timed to coincide with the annual flood and its associated abundance of food. When *eutrophication* is due to Man's activities it is known as *cultural eutrophication* and is caused by nutritionally useful, man-derived, materials entering an ecosystem. This often causes a 'bloom' of a species. *Cultural eutrophication,* then, is a symptom of organic pollution, usually by addition of sewage or fertilizer laden run-off water to, say, a stream. Green (1972) points out that this enrichment is accompanied by a reduction in diversity of the flora of affected water courses; that is, one species tends to take over.

In caves too, *eutrophication* tends to lead to a change in species, *troglobitic* forms often being replaced by commoner *troglophiles.* This effect is seen clearly when tropical (*eutrophic*) and temperate caves are compared. Tropical caves often have large guano deposits left by bats. This is enought to feed considerable populations of *troglophiles* and *guanophiles.* It is thought that *troglobites*—true cave dwellers—are more numerous in temperate regions where food is not as abundant. For example, even Devon's modest caves support two species of troglobites: *Pseudosinella dobati* (Collembola, Insecta) and *Niphargellus glenniei* (Gammaridae, Amphipoda, Crustacea).

Some ecologists separate 'natural' effects and 'man-made' influences which would imply that Man is not part of the ecosystem. Man is undoubtedly altering cave environments, which may or may not be a good thing but could be viewed as a natural evolutionary process.

Enriching the environment by adding more food increases the numbers of organisms in the cave, perhaps to the advantage of the troglophillic organisms (animals which occur on the surface) at the expense of the rarer *troglobites.* Before Man's influence on a habitat is condemned, more should be learnt of how and why the environment is being altered. Conservation should be an active process—not at all akin to the preservation of

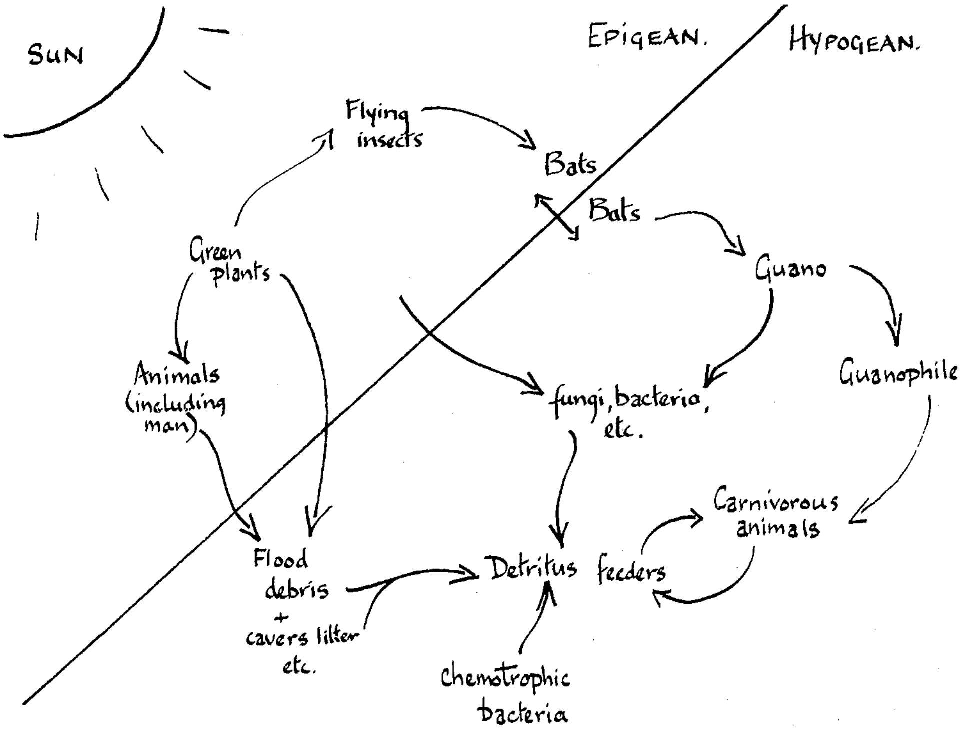

Figure 33
The Cave Ecosystem.

specimens in a museum—and management to conserve should be carried out after an informed review of all the factors involved. There is a case for maintaining the respective faunae of unexplored, moderately used and over-used caves. Each would be expected to have characteristic faunae, in different parts of the country. Similarly caves taking nutrients—sewage or fertilizers—or even pesticides may support interesting and very different faunae that would be worth conserving.

Many ecologists have concluded that to effectively protect any body of water from organic or inorganic pollutants, the whole water catchment area must be protected. Even the apparently harmless practice of abstraction of water from the river upstream of the cave, may have a marked effect. Conservationists aim to acquire ownership of a whole valley or river system as it has been realised that protection of one small portion of a water system little helps their cause. If a cave is to be preserved and kept in an uncontaminated state the area above, surrounding and the entire water catchment area serving the stream or river should be investigated. As in many such ecological investigations this needs the combined efforts of speleological specialists of a variety of disciplines:

i. The information that the hydrologist can supply is of great value.

ii. Chemists are needed to analyse sinking, resurging and drip or seep water.
iii. Cave geomorphologists.
iv. Cave meteorologists to study microclimate, especially humidity.
v. Biologists to measure species, distribution and numerical changes, in order to assess whether biotic alterations are due to natural fluctuations or to Man-induced changes.

Springs are traditionally givers of fresh water. Cave exploration has shown that because water often passes quickly through aquifers and caves, it is seldom significantly filtered and purified as it passes through limestone (and chalk?). Caves and aquifers offer a by-pass to the slow seepage and percolation route for natural water and it is sometimes forgotten that pollutants can travel considerable distances if they are transported by underground streams. It seems that some overlook the fact that dumping of noxious materials on limestone substrates leads to some unexpected and unpleasant reappearances of dumped wastes. The 'out of sight out of mind' attitude just does not work in limestone (and probably chalk) areas. Abandoned limestone quarries are sometimes infilled with refuse, as has been the case above Baker's Pit Cave in Devon. Here black slime and highly toxic chemical wastes are percolating down into the cave, into the subterranean streams of the cave system and some of the wastes find their way, from there, into surface watercourses that may be used to supply water for human consumption.

In Swildon's (4) Hole on Mendip, too, land use above the cave is causing a faunistic change. Agricultural wastes percolate down into the Cowsh Avens area and, because of this, Sump Four is unpleasantly smelly and supports a rich fauna of *troglophiles:* gammarid shrips, tubificid and enchytraeid worms.

Inputs of pollutants of agricultural, industrial and domestic origin entering caves, then, have two effects:

1. *Eutrophication* of caves leads to population explosions of facultative cave dwellers *(troglophiles)*.
2. Cave fauna, particularly aquatic species, are directly poisoned and surface and underground water courses not obviously connected with the cave in question are contaminated by inorganic and organic compounds.

Land use directly above (as well as upstream of) the cave is of great significance, then. Pollutants may percolate down into the cave system surface (micro-organisms certainly do) through joints and cracks and there are other effects. A housing estate has been built above Radford cave, near Plymouth in Devon. This has effectively put a roof on the cave and has cut down the amount of water that seeps in from above. The cave, which does not take a stream, seems drier now than before the building development and the humidity in the larger chambers is probably too low to allow humidity sensitive insects, particularly springtails (Collembola), to survive (Wilson, 1975). Many cave dwellers are likely to dessicate if the relative humidity within the cave falls much below 100 per cent; this is another important type of change, therefore.

By using a cave, cavers alter the underground habitat. Digging into new passages may alter air circulation patterns and cause a reduction in humidity (Long, 1974) which probably slows stalactite growth and disperses insects. Entering new caves allows the introduction of micro-organisms, increases food available by the importation of minute pieces of litter, clothing, etc. and possibly disperses animals (Wilson 1976). Food is so scarce in temperate caves that surprisingly small quantities provide a useful food supply. Even a hair will support a number of springtails, grazing on the fungi which grow on that hair.

Cave conservationists understandably tend to concentrate their efforts on the not unimportant task of protecting the cave itself, often solely against vandals, perhaps not appreciating the other ways that a cave may be changed. Man's effects on cave ecosystems are summarised in the figure and below:

1. Cultural eutrophication via:
   a) Nutrient (or pollutant) laden run-off water entering rivers upstream, then being carried into the cave.
   b) Polluted seepage water.
   c) Caver's rubbish and contaminating organisms brought in by cavers.
2. Water input affected by:
   a) Water abstraction.
   b) Building directly above the cave.

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GLOSSARY

Abiotic—lifeless

Allochthonous—material brought in from another ecosystem; not produced by ecosystem in question.

Chemotrophic—animals acquiring energy from rock (i.e. from chemical bonds—not directly from the sun).

Ecosystem—a complex of animals, plants, soil, etc. in one discrete habitat or defined area.

Endemic—occuring only in one area/cave system.

Epigean—the surface habitat.

Eutrophication—enrichment of, or addition of a surfeit of food nutrients to, a biological system. Cultural eutrophication—man induced eutrophication.

Guanophile—An organism that lives in, and acquires its nutrition from, guano. Not necessarily a cave dweller.

Hypogean—the underground habitat.

Troglobite—a true cave dweller; never found on the surface.

Troglophile—an animal which lives and reproduces both underground and above-ground.

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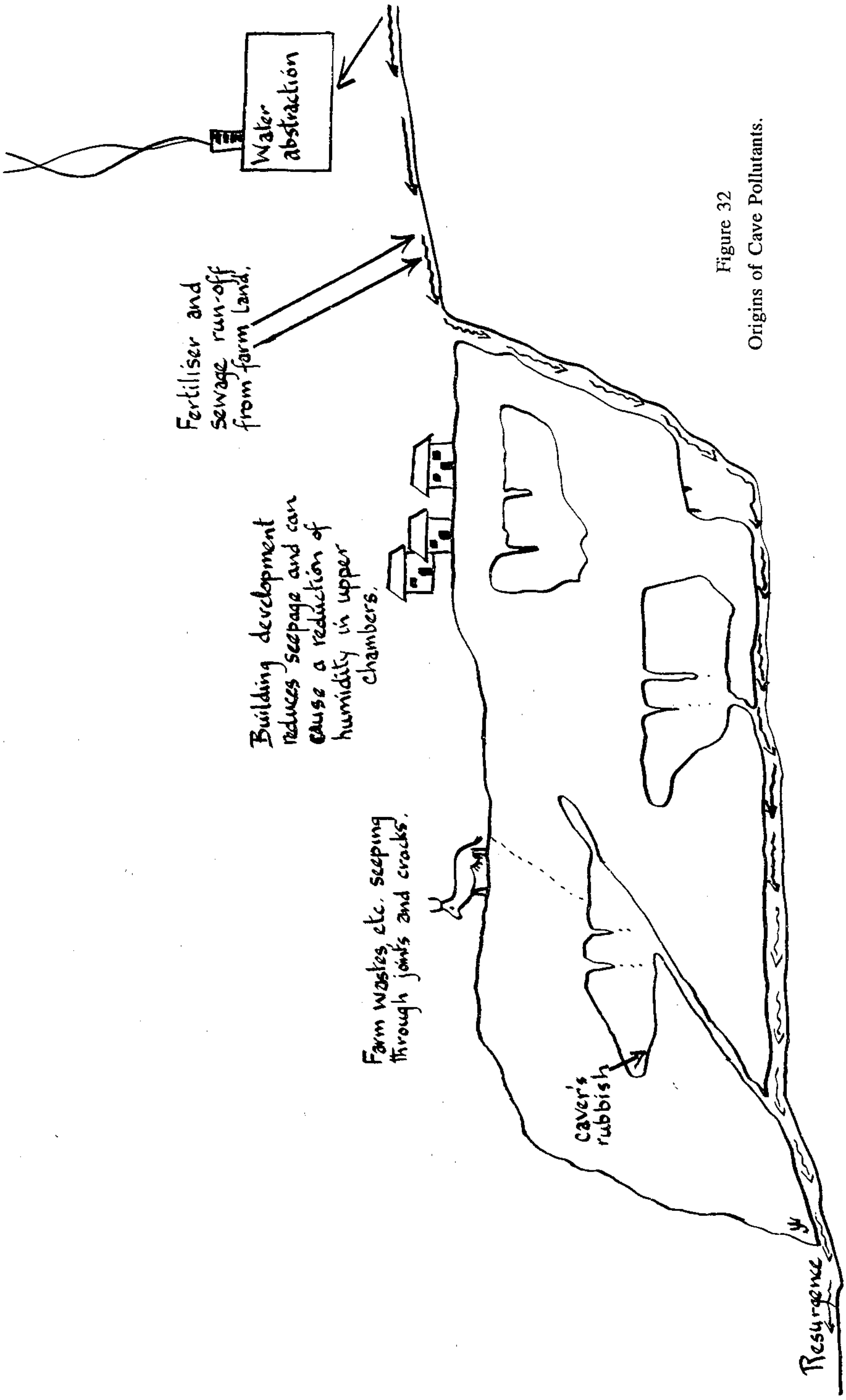
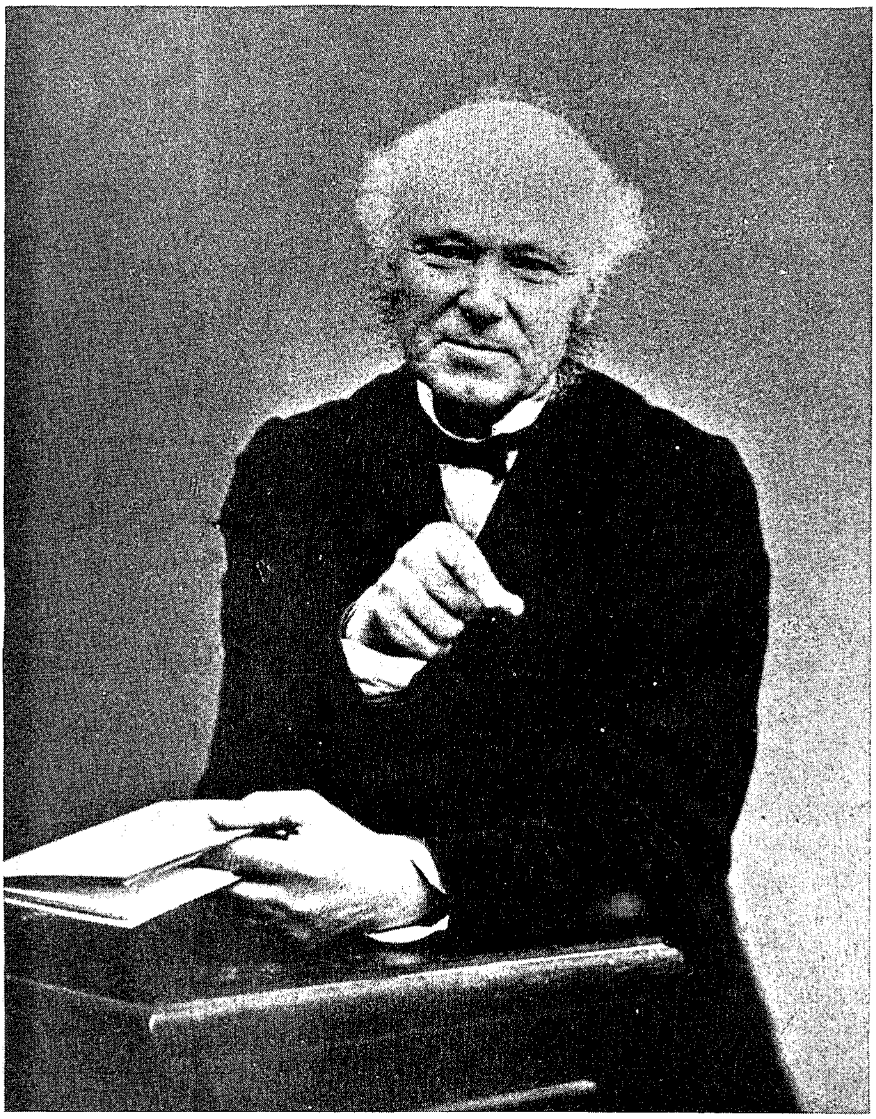


Figure 32
Origins of Cave Pollutants.

A LITTLE KNOWN PHOTOGRAPH OF WILLIAM PENGELLY, 1812–1894



The appearance of William Pengelly, excavator of Kents Cavern, is best known from the rather stern oil painting which hangs in the reading room of the Torquay Natural History Society and which was reproduced as the frontispiece of volume 1, part 1 of this journal. There are only two or three known photographs of Pengelly of which this is the most relaxed and informal. It is reproduced with grateful thanks from the archives of the Torquay Natural History Society, assembled by the late sisters Hamblin.