

CAVE SCIENCE TOPICS

Damming up the Caves

by William R. Elliott

In November, 1978, the U.S. Army Corps of Engineers completed a rock-fill dam that will inundate at least 33 caves along Northern California's Stanislaus River. The caves in this area and in the entire Mother Lode Region are a largely untapped scientific resource. The Corps of Engineers is well aware that many of these caves contain potentially significant archaeological, geological, palaeontological and biological phenomena that are irreplaceable. The Corps itself sponsored a cave inventory and evaluation project by a multi-disciplinary team of speleologists in the spring of 1977. Led by J. Michael McEachern and the late Mark Grady of Southern Methodist University's (SMU) Archaeology Research Program, this team studied 87 caves that will be directly or indirectly affected by New Melones Lake. The team's report detailed the resources and values that will be lost by the flooding and recommended a series of 'mitigative' actions — field studies which could salvage valuable scientific data before the caves go under. Some of the studies would require a delay in filling the lake, a strategy to which the Corps has not committed itself.

During the winter of 1977-78, I was employed by the Corp's Sacramento, California, office to conduct a special mitigative project — transplanting a possibly endangered species of cave-dwelling harvestman, *Banksula melones*, to a gold mine. First, let us examine some of the events which led to the funding of this bizarre project.

Banksula melones is a tiny (two millimetre body length) arachnid belonging to the Order Phalangida. It is *not* a spider, but a harvestman or 'daddy-long-legs,' which is quite a different thing. All *Banksula* species are troglobites, forms which are adapted to cave-dwelling and which are found only in caves. Unlike many troglobites, some *Banksula* species still have small eyes. The five described and four undescribed species of *Banksula* are known only from caves in California's Mother Lode Region of the Sierra Nevada and are of some evolutionary and ecological interest to cave biologists, arachnologists, and zoogeographers, as are all troglobites.

Until 1979, *Banksula melones* was known from two caves: McLean's Cave, which will be flooded, and McNamee's Cave, which is in a private quarry and will be destroyed eventually. Both caves are in Tuolumne County. McLean's Cave is one of the more interesting caves in the region. Of the 87 caves studied by the SMU team, it ranks first on their list of scientific value because of its sedimentary record, palaeontology, and biology. I found that McLean's contains at least 35 species (mostly arthropods), making it perhaps the most diverse cave ecosystem in California. Unfortunately, ecosystems are not protected by the U.S. Endangered Species Act.

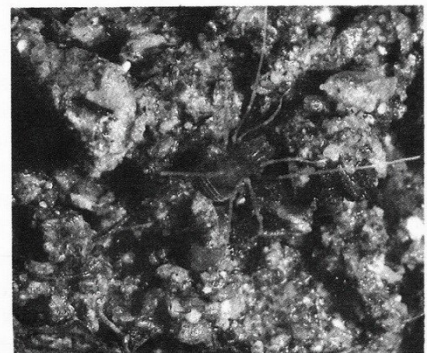
If *B. melones* were doomed by flooding and quarrying, why was it not placed on the Endangered Species list? The act, in its original and recently amended forms, protects all endangered and threatened animal and plant species that are not pests. Cave animals such as *Banksula* are not pests. The answer is that *B. melones* was a political 'hot potato.' Had it been listed, it could have meant stopping a \$340 million dam project.

In 1971, Tom Briggs, a biospeleologist, arachnologist, and chemist with the California Academy of Sciences, informed the Corps' Sacramento office of the possibly endangered harvestman and asked that efforts be made to preserve it and the community upon which it depends. In 1972, the Corps said in its environmental impact statement for the lake that it was considering relocating the harvestman and other cave animals to other caves. Nothing noticeable happened. Briggs formally described *B. melones* and four other new *Banksula* species in 1974. In 1975, Briggs notified

the U.S. Office of Endangered Species (OES) of the status of *B. melones* and *B. grahami* so that they be studied for endangered species status. *B. grahami* is a widespread species that also inhabits McLean's Cave. Shortly afterwards the Corps financed Briggs to transplant *B. melones*, *B. grahami*, and other fauna from McLean's Cave to an abandoned quartz-gold mine in the same canyon. This small project resulted in the transfer of 17 arthropod species, including 22 *B. melones*, 17 *B. grahami*, and five *Banksula* juveniles (which usually cannot be identified as to species). These harvestmen are highly secretive and difficult to find. Briggs, although he had much volunteer help, could find no more than these few specimens in four months of part-time work.

The OES and its parent agency, the U.S. Fish and Wildlife Service, wanted to avoid a controversy like the now famous Tennessee Snail Darter case, in which an obscure, endangered fish caused the abandonment of a dam project. The OES neither condemned nor condoned the transplant, but in March, 1977, they notified the Corps that the success of the transplant could not be measured in months but only after years.

By 1978, the U.S. General Accounting Office (GAO) was investigating the foot-dragging at the Fish and Wildlife Service on the harvestman case. In August, 1978, the GAO's findings were relayed to the House of Representatives via a report from the House Marine and

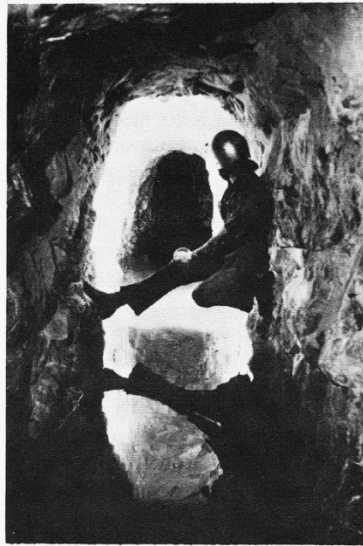


Banksula melones from McLean's Cave (2mm body length). This species was the reason for the ecological transplant to the mine, but ironically is no longer considered endangered. Photo: W.R. Elliott.

Fisheries Committee. The committee justified an amendment to the Endangered Species Act on the basis that the Fish and Wildlife Service had omitted the harvestman from the Endangered Species List for fear of provoking Congress into major revisions of the Endangered Species Act. According to a newspaper account at about that time, a top official at the Department of the Interior had told the GAO that, "The Endangered Species Act is more important than two spiders." This statement belies what I and other invertebrate zoologists often call "The Vertebrate Bias." The idea of defending cave 'bugs' must have seemed unattractive.

The idea of transplanting an entire cave community to a mine is questionable, but it is perhaps better than transplanting to another cave, at least in this particular situation. The 'Transplant Mine,' as it is now called, was excavated about 50 years ago in the same marble formation as the local caves were formed in. It has a cave-like microclimate, and it could be considered an almost empty habitat to establish colonies in. The few arthropods already established in the mine were opportunistic species commonly found in many local caves anyway. Moving an intricately balanced community to another natural cave might damage two communities instead of one. Besides, the other available caves in the area might later be found to contain their own rare species. One must also remember that McLean's Cave had to be considered doomed by flooding anyway, so any attempt to mitigate such destruction was better than nothing. However, the transplant approach was fraught with many practical and theoretical problems unforeseen by the Corps. In a sense, it was an engineer's solution to an ecological problem.

Tom Briggs inspected his transplant site at yearly intervals, but it became apparent that neither *Banksula* species was doing well. The observable numbers dropped to five *B. melones*, five *B. grahami*, and four juveniles by November, 1976. Unknown to Briggs and the Corps, a claim was filed on the mine at the Tuolumne County courthouse in October, 1976. The two miners were unaware that a transplant had been made and they filed a legal claim for land administered by the U.S. Bureau of Land Management. The BLM and Corps had previously agreed that the BLM would



Andy Grubbs in the entrance tunnel of the Transplant Mine. Photo: W.R. Elliott.

protect the mine until it could be transferred to the Corps, but apparently no one bothered to check with the county. Although the mine was gated, the miners entered and drilled dangerously close to the transplant site, possibly affecting it. They later dropped their claim when apprised of the situation.

By August, 1977, only four *B. grahami* were found in the mine, but no *B. melones* or juveniles. This was at the peak of the recent California drought and the mine was drying out.

The Corps decided to make a larger transplant and contacted me as Briggs was occupied with doctoral research. I agreed to do the work but persuaded them to allow me to search other caves for the harvestmen on the chance that another, unthreatened site might contain *B. melones*. By this time it was generally recognised that *B. grahami* was not in danger, it being the most common cave harvestman in the area. The SMU team had been able to make biological collections in only one-third of the caves they visited and none were close to McLean's Cave. With the drought and poor conditions in some of the caves, it would not be surprising if some fauna had gone undetected.

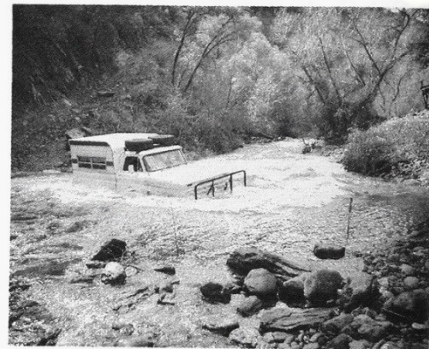
Two young speleologists assisted me in the field work. Steve Winterath from California, and Andy Grubbs from Texas had both worked on the SMU project and were well acquainted with

the caves and fauna in the area. We started with some census work in McLean's Cave and the mine in December, 1977. Oddly enough, seven *B. melones* and 11 *B. grahami* were found in the mine at this time.

In mid-December the drought broke abruptly. The superabundance of rain soon caused two problems: the logistics of getting to the cave and mine on treacherously steep and muddy four-wheel drive roads, and the fact that the mine was beginning to flood from internal seepage.

Commuting to work was usually no great hardship. Changing muddy, heavy-duty tire chains became a daily routine. Forging the South Fork of the Stanislaus to get to McLean's was challenging when the water came up to the headlights of my high-clearance truck. When that became impossible because of the rampaging river, we used cavers' ingenuity and rigged a 50-metre steel cable traverse and crossed on a pulley-and-Swiss-seat-joyride. Hauling heavy containers of cave soil and fauna across the cable was not always fun, but then neither was reconstructing several hundred metres of steep trails by hand. We even constructed a footbridge out of some abandoned mining gear, but it eventually washed out. We began to feel like engineers, much as we hated to admit it.

The mine developed a 23-centimetre-deep pool in the front section that threatened to back up into the slightly higher portions at the rear where we planned to place new colonies. Some fauna with which we had restocked the original colony was drowned when it wandered into the small stream in the



Crossing the South Fork of the Stanislaus River on the way to McLean's Cave. Photo: W.R. Elliott.

main tunnel. Actually, we were lucky to see the mine at its worst because we might have blithely placed colonies in vulnerable spots had the drought continued through our project. We selected two side tunnels which were relatively high and out of the path of the stream. Before transplanting more animals, we built up the floors of these sites with 2,600 kilograms of mine tailings that we transported by hand from just outside. This coarse rock also offered hiding places for the harvestmen and other species.

Eventually, we were able to partially drain the pool and keep it at a lower level. However, the mine water rapidly deposits calcite, and may eventually cause worse flooding as natural rimstone dams are built up. The mine has already formed many speleothems in only 50 years.

Our attempt to census the community in McLean Cave failed, although we had set and regularly checked 60 pit traps throughout the cave. The traps were baited with various materials, and we were able to get large numbers of springtails, psocids (book lice), and leiodid beetles, but the harvestmen studiously avoided the traps. We transferred 470 kilograms of cave soil to the mine in hopes that it might provide ecological requirements for some of the fauna. One hundred sixty kilograms of rotting wood were laid over the sites to provide an organic source for fungus growth (many cave animals, such as springtails and millipedes, graze on fungus). To maximize the harvestman's chances of survival, we had to transfer as much of the community as possible since practically none of their requirements were known. No one even knew what *Banksula* species ate, although their raptorial pedipalps (feeding appendages) indicated that they were predators. We did some simple feeding experiments that showed that they will devour springtails and psocids.

By the end of the project we had transplanted at least 27 species of arthropods for a total of 1,355 live individuals*. In all, 26 adult *B. melones*, 99 *B. grahami*, and 26 *Banksula* juveniles

*Included in the mix were the following species: two spiders, four pseudoscorpions, perhaps six mites, one centipede, two millipedes, a symphylan, several springtails, one japygid dipluran, one psocid, three beetles, one roothopper, several flies, and one isopod. At least seven of these species are troglobites.

were transplanted alive. On the average, two man-hours of searching and hand collecting were required to locate each harvestman in the cave.

Banksula grahami is far more abundant than *B. melones* in McLean's Cave. Identifying the two species in the field is difficult. Most harvestman species are identified on the male genital morphology, and this requires preservation and microscopic study. Briggs showed us how to separate live specimens with a hand lens — *B. melones* is slightly larger, darker, and has larger eyes. However, it is necessary to have several specimens together to make the comparison.

Our efforts to collect and transplant as much fauna as possible resulted in ecological trauma to McLean's Cave. We found that *B. melones* was becoming nearly impossible to find after 40 days of collecting. Some press reports claimed that *B. melones* was driven to extinction, but it was found and studied in McLean's Cave in a later project.

Our visits to seven other caves in the area yielded no *B. melones* but we did find new localities for *B. grahami*. An off-hours visit to another cave outside the lake area yielded a new species of *Banksula*.

A follow-up inspection of the Transplant Mine in May, 1978, revealed at least three species of fungus on the wood, about 57 *B. grahami*, but no *B. melones*. Several teams visited the mine in July, August, and December, 1978, but one possible *B. melones* was seen. It seemed likely that *B. melones* had already died out in the mine, although the possibility remained that it



Microcreagris grahami (about 2.5mm body length) is a troglitic pseudoscorpion from caves in the New Melones Lake area. Photo: W.R. Elliott.

had dispersed and hidden and could not be found easily.

My final report to the Corps in November, 1978, concluded that the transplant of *B. melones* was a probable failure. Repeated inspections over many years would be necessary to evaluate the success of the transplant. I recommended, among other things, that no more transplants be made unless this one could be proven successful, and that a thorough search for *B. melones* in other caves should be carried out.

The transplant seemed almost doomed to fail from the beginning, despite the great amount of effort put into it. Before starting the work I told representatives of the Corps that there were many reasons why it should not work and few why it should. Here are some of the more obvious problems that I outlined in my report: the mine is too wet and may only get worse in the future; the two harvestman species may be competing, which may hasten the demise of one or the other; the ecology of the cave was too poorly known to expect to duplicate it, and even if it had been duplicated the mine does not have the same food inputs as the cave; the artificial food source (wood and fungus) may be inappropriate and in any event would have to be restocked from time to time; the survival of all components of the community may be necessary for the survival of *B. melones*, but we can probably expect that some species will rapidly go extinct in the mine while others 'blossom' (if only for a few generations before they 'crash'); assuming that they can reproduce in the mine, the exceedingly small founding populations of harvestmen and other species may lead to considerable inbreeding and 'genetic drift' (a loss of genetic variability), which could lead to a loss of adaptability and to eventual extinction when conditions in the mine change; finally, the mine may still be vulnerable to mining claims. As a test of the last problem, a conservationist group (which I shall not name) has actually held a Tuolumne County claim on the mine from May, 1978, through 1979. The Corps and the BLM never discovered this. Fortunately, the group had no intention of mining the claim.

The OES finally decided to do a field study and hired D. Craig Rudolph through the World Wildlife Fund to search for *B. melones*. Craig and his fel-

low workers, Steve Winterath, Barbara Martin (Canada), and Bert van Ingen (Canada), worked from January to May, 1979. James Reddell and I (Texas biospeleologists like Craig) spent two weeks working with the project. Several surprises were in store.

A search of the rugged canyon face above McLean's Cave revealed a new entrance, hidden behind a buckeye. Vulture Cave, as it is now known, is above the future lake level and contains a small population of *B. melones*. Intensive searching in other Tuolumne County caves yielded three new populations of *B. melones*. Additional specimens from seven previously studied caves across the river in Calaveras County led Tom Briggs to conclude that they were actually *B. melones*, rather than a new species of *Banksula* as he had previously thought. This sort of thing is not unusual in taxonomy when the full range of variation in a species is poorly known because of a small number of known specimens. Additional collecting located five other *B. melones* populations in Calaveras County. Collecting conditions had greatly improved since the end of the drought. In all, there are now 18 natural populations of *B. melones*. Three of these are in caves to be flooded. All but two of the populations are within a two kilometre radius.

In March, 1979, we made a census in the Transplant Mine and found harvestmen to be abundant there. We easily collected 132 live specimens in a few hours. This was a pleasant and unexpected surprise to all of us. We were even more surprised when Tom Briggs identified about two-thirds of the specimens on the spot as *B. melones*. Many

small juveniles were seen, so it was obvious that a population bloom had occurred. Microarthropod prey were abundant, so the transplant looks promising, for the moment.

A crisis was averted. *Banksula melones* will not be listed as endangered or threatened after all. But is this a satisfactory denouement to the story after all? I think not.

A beautiful white water river will be lost, a favourite among rafters and other nature lovers. Thirty-three caves of scientific, aesthetic, and recreational value will still be flooded. Some of the caves contain Indian artifacts, some contain Pleistocene fossils, and some contain potentially valuable sedimentary records, unavailable above ground, that could help unravel the Tertiary history of the region. The fauna of these caves is yet poorly understood. Numerous collections remain to be identified, catalogued, and described. Given the highly endemic nature of many cave species, it would not be unusual to find that some of the caves do contain endangered, but as yet undescribed species. The entire community at McLean's Cave and other caves deserves preservation. Each is an important datum in understanding the evolutionary history of the region. Since the caves to be flooded are at the upper end of the future lake, a slight lowering of the planned lake level would preserve them. The lake is slowly filling and time is running out. A good rainy season could fill the lake but even with normal weather it will be filled in two more years. Meanwhile the State of California and the federal government continue a drawn-out court battle over who is supposed to set the lake level. The State wants to keep it lower.

And what of the Transplant Mine, and the transplant philosophy in general? At best it is an experiment which ought to be followed with interest. For this reason I recommended to the Corps that it be secured permanently as a study site. At worst it is a gimmick, a pseudo-solution. It does not reproduce the intricate relationships of McLean's Cave. It is a zoo, and eventually it will decline without careful management. Essentially the same may be said of other, expedient, ecological transplants, such as the relocation of the Devil's Hole Pupfish from Nevada to a cement tank below Hoover Dam on the Colorado River. That transplant was necessitated by a drop in the water level of the fish's natural habitat, caused by over-pumping of the regional groundwater. Possible genetic drift has been noticed in the transplanted pupfish population since its introduction in 1972.

Will the transplant philosophy become an accepted way of dealing with endangered species? Will invertebrates continue to receive short shrift in the enforcement of the U.S. Endangered Species Act? Will we continue to destroy our valuable repositories of natural history, the caves? ■

Further Reading

'The New Melones Cave Harvestman Transplant' (1978) by William R. Elliott, a 62 page technical report is available free from: District Engineer, U.S. Army Corps of Engineers, 650 Capitol Mall, Sacramento, CA 95814.

'An Inventory and Evaluation of the Cave Resources to be Impacted by the New Melones Reservoir Project, Calaveras and Tuolumne Counties, California' (1978) by J. Michael McEachern and Mark A. Grady can be obtained from the Adobe Press, 515 Isleta Boulevard S.W., Albuquerque, NM 87105.

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