Use Of Chemical Methods For The Control Of Lampenflora: Sodium Hypochlorite And Hydrogen Peroxide

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Abstract

To avoid the development of lampenflora the first action is a proper intervention on the lighting. But if lampenflora develops, notwithstanding a good lighting system, it is necessary to adopt some action to stop its growth. The chemical methods, which have the best risks/benefits ratio, utilize sodium hypochlorite and hydrogen peroxide. Here advantages and problems of both compounds are discussed.

Introduction

It is well known that lampenflora is a typical problem in show caves, because the light that is necessary for the visitors supplies enough energy to some plants, which may grow to the point of seriously defacing and damaging the cave itself.

Therefore it is extremely important to avoid the development of lampenflora by adopting the best solutions in order to keep as low as possible the supply of energy for its proliferation.

Notwithstanding the implementation of the best methodology to control such a development, in many instances there is a growth of lampenflora, which must be destroyed by appropriate methods.

Chemical methods

Many products have been used up to now with different results and disadvantages. In particular strong herbicides, which were sometimes suggested in the past, must absolutely be avoided because of their toxicity on the cave environment.

Among the chemical substances which are frequently used to control lampemflora in show caves, sodium hypochlorite (NaOCl) and hydrogen peroxide (H_2O_2) are the most popular (Aley, 2004; Mulec & Kosi, 2009; Cigna, 2011).

Sodium hypochlorite (NaOCl)

This substance is probably the most commonly used because it is the bleach that is frequently used at home and, therefore anyone is quite familiar with it. There are two main negative aspects: the smell and the law.

The smell is well known because we are accustomed to it any time it is used at home. Luckily it disappears in a short time and therefore it is not a big practical problem. But in many countries the law forbids it or, at least, its use has a number of constraints.

According to some authors (Faimon et al., 2003; Mulec & Kosi, 2009) it represents a burden for the cave environment. From a theoretical point of view they are quite right because Cl is surely a poison, but since we are dealing with a show cave where the impact by the visitors on the cave fauna is already relevant, the additional negative effect of sodium hypochlorite is in general negligible. It must be stressed that such a treatment with sodium hypochlorite is not carried out frequently (from one to a few times per year, in general) as it still reduces its impact, since the concentration commonly used is at 5%.

Hydrogen peroxide (H_2O_2)

It is difficult to find another substance more environmentally friendly because the products released into the environment are water and oxygen. Therefore from this point of view hydrogen peroxide seems to be absolutely the best choice.

Faimon et al. (2003) studied extensively the effects on limestone and calcite speleothems. They found that the dissolution rates by hydrogen peroxide at a concentration of 15%$_{vol}$. are one order of magnitude higher than the corresponding rates by water. Therefore hydrogen peroxide attacks carbonates somewhat more aggressively than karst water.

To avoid this effect they experimented with a simple procedure consisting of leaving the hydrogen peroxide solution at 15%$_{vol}$. to react with a few fragments of calcite for a minimum period of 10 hours, but not prolonged over 24 hours, before the application of the solution. A near complete saturation with respect to calcite is reached and the solution will not significantly attack calcite.

The treatment of lampenflora with hydrogen peroxide is somewhat less effective than hypochlorite. Exposure of the eyes to concentrations of 5%$_{vol}$ or more can result in permanent eye damage. Skin exposure causes painful blisters, burns and skin whitening. Therefore special attention must be paid when used to control lampenflora because the concentration is three times higher than the limit reported above. The fact of being odourless is evidently an advantage when compared to the smell of sodium hypochlorite but, on the other hand, it does not prevent exposure to the skin without any warning.

Conclusion

Both compounds reported above have a number of advantages and risks. The choice between them should take into account carefully their characteristics and the local situation.

First of all there are a number of constraints established by the law, which may be different according to the country. Such constraints depend both upon the principles of safety of individuals and protection of the environment. The trend in the establishment of limits for toxic substances is negative in a mathematical sense, i.e. their value is continuously lowered. Sometimes such a procedure, instead of achieving an increase of safety for the person exposed to the toxic chemical leads to a status of overprotection. In fact when the values become too low they imply an additional burden, which is not rewarded by real improvement of safety.

Since chlorine is poisonous the trend is to consider also its compounds as possibly poisonous. This assumption is correct in many instances, but the degree of danger depends on the amount or the time of exposure. Therefore an occasional exposure to bleach, as it happens at home, should never be considered as a dangerous situation for anyone in a cave, cave guides included.

In practice the most evident problem is due to the smell that, luckily is not persistent and disappears in a short time.

For the cave fauna it was already reported above that the impact of visitors in the tourist part of a show cave is much more relevant in comparison with a low concentration of sodium hypochlorite when some lampenflora is washed away. In addition it must be stressed that the cave fauna moves out from the tourist pathway into wild parts of the cave, where the possible concentration of sodium hypochlorite is still lower.

Moving to hydrogen peroxide, the biocide effect is due to a strong oxidation reaction without the release of products harmful to the environment. But, as it was reported above, a concentration of 15%$_{vol}$, which is necessary to achieve a good result in the treatment of lampenflora, may have no negligible health effects for the persons using it.

The dissolution rate of calcite by hydrogen peroxide, which is about 10 times higher than karst water, is around 1 g m^{-2} h^{-1}. From the point of view of a limestone wall or most formations, such an effect may be considered negligible because the exposure time to hydrogen peroxide is rather short. On the contrary in the case of speleothems with a glossy surface, e.g. cave pearls, the action of hydrogen peroxide could deface the formation.

Faimon et al. (2003) stated that as cleansing agents against lampenflora only "two alternatives" remain: either (1) the rapid and effective lampenflora elimination with hypochlorite, albeit with cave "devastation" or (2) environmentally acceptable but slower and less effective eradication using hydrogen peroxide.

Such a rather strong statement could be reduced, given the long experience of Bertolani et al., (1991) with sodium hypochlorite which was found not to deface the cave environment. According to Aley (2004) treating areas as soon as the lampenflora is visible minimizes adverse impacts and, possibly, the runoff of the treating solution should be captured.

When hydrogen peroxide is used, it is possible to avoid the corrosion of calcite, with a previous saturation with calcite, as suggested by Faimon et al. (2003) or the procedure suggested by Grobbelaar (2000) with the application of hydrogen peroxide followed by washing after 5-10 minutes with karst water. This author suggested also collecting the wash water, but probably the hydrogen peroxide had already decomposed after the treatment and therefore it is not necessary to perform a special disposal of

the wash water. If necessary this treatment could be conveniently repeated after 6 months or one year but it must be stressed that the use of other chemical biocides may seriously endanger the cave fauna and therefore must be avoided.

References

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