THE ROCKINGHAM MAUSOLEUM
WENTWORTH, SOUTH YORKSHIRE

To clean or not to clean?

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The visit to the Rockingham Mausoleum took place on a wet and windswept day in mid-December, at the invitation of Anthony Barber-Lomax, on behalf of the Fitzwilliam (Wentworth) Estates.

The Fitzwilliam Wentworth Amenity Trust is currently considering the utility of cleaning the Mausoleum and adjacent obelisks. Chemical cleaning of the Doric Temple was carried out some 12 months ago and an inspection of this structure was included in the itinerary.

The following represents a provisional opinion regarding the possible cleaning of the mausoleum.

The Rockingham Mausoleum was designed by John Carr and constructed between 1784-1789. It was built in commemoration of William Wentworth Fitzwilliam. The obelisks that so set off the mausoleum itself were not part of the original design but were incorporated in 1793, brought from the west front of Wentworth Woodhouse. (Wragg, *The Rockingham Mausoleum (1784-1793),* Yorkshire Archaeological Journal, vol 52, 1980,)

The architectural carving for the monument was carried out under the auspices of Thomas Waterworth of Doncaster, the building and much of the masonry carving by Samuel Sykes Charles Hobson and Company. The statuary within the monument was the work of Nollekens. (Wragg, p164)

When first constructed, the monument stood on a bare and extremely exposed hill-top. Trees were planted in its vicinity as part of the design. These remain as mature trees today.

The Mausoleum is listed Grade 1.

The Rockingham Mausoleum. Note the as yet little-soiled replacement stonework, as well as the cleaner sections beneath cornices, illustrating the limit of effectiveness of drips. Also the grey chemical cleaning test panels to the lower right-hand corner

Both mausoleum and Doric Temple form part of the landscape before the former house of the Wentworth Woodhouse family. They may be counted remnants in the sense that much of the landscaping was seriously disrupted after WWII by drift mining. Much that is seen today is subsequent back-filling.

That said, the monuments each stand alone in cultural value and have a direct relationship with one another, each standing upon a promontory and each visible from the other, between clear sight lines bounded by mature trees. The Doric Temple commands wide views beyond the boundaries of the Estate; those of the mausoleum are more confined and inward-looking, perhaps appropriately so, wider vistas being blocked by trees.

The Doric Temple

When considering the desirability of cleaning, the intention of the architects and builders should be considered. The primary purpose of these monuments was as focal points in the landscape to be mainly viewed from afar; occasionally to be visited. Insofar as this may be true, they have always been viewed mostly as silhouettes. The darkened hue of the mausoleum today, and that of the Doric Temple before cleaning may not be viewed as inappropriate in this context.

The location, the 'place' of both is rural and relatively remote. They are not part of an urban landscape, in which 'cleaner' buildings might be considered more pleasing or appropriate. They need not be expected to respond to urban sensibilities.

The pattern of soiling to the mausoleum reflects the pattern of its construction, the materials of its construction, as well as its environment. It is appropriate in this sense. Importantly, this combination of factors is unlikely to be significantly altered by cleaning: the soiling will inevitably return, although not necessarily in quite the same way.

The primary motives for cleaning are aesthetic and, less subjectively, structural. If the nature of the soiling represents a demonstrable decay mechanism, or actively aids and abets the action of other decay mechanisms, then cleaning should be seriously considered. Aesthetic judgements are more fickle and time-specific. The cleaning of building facades may reasonably be considered to improve the reading and therefore the appreciation of some buildings; it may be an important (social) tool in urban regeneration, if it is part of a strategic plan and is not carried out piecemeal.

Note that the elevation that faces the prevailing wind is blackened, whilst the leeward elevation is green. This may be due to a higher concentration of carbon aerosols from industrial pollution on the face that receives the most direct, windblown precipitation. Note also that the algae has reasserted itself more readily on the leeward side than upon the more exposed -and blackened- elevation.

Alternatively, a degree of soiling is an inevitable and appropriate consequence of ageing, and of character. It may enhance the reading of a building, accentuating the effects of light and shade intended by its builders. There is a soiling curve: up to a point, weathering and soiling may improve a building; beyond a certain point, it may confuse and distract and obscure detail, even where it does only minimal physical damage. No cleaning programme should seek to make a building 'new' again, although it may be considered a worthy objective to return it to an earlier point upon the curve.

It is my opinion that there is currently no overwhelming aesthetic argument to clean the mausoleum.

The call must rather be made on the basis of these considerations: does the current pattern and nature of the soiling represent a clear and progressive decay mechanism in itself? Does the soiling enhance the destructive potential of other decay mechanisms? Might the cleaning options themselves cause unwarranted loss of fabric or enhance the destructive potential of other unavoidable decay mechanisms? How quickly might the soiling be expected to re-establish?

The much less exposed and much less frequently wetted and much less extensively soiled front elevation of Wentworth Woodhouse,

Similarly, the stables of Wentworth Woodhouse. It is not known to me if, when or how these buildings might have been cleaned. Note the heavy soiling of weathering and frequently wetted elements

What is the soiling?

As related by Nicola Ashurst, the initial assumption of all concerned before the cleaning of the Doric Temple was that its blackened appearance was a result of atmospheric pollution, and chemical cleaning was the preferred option. Once work began in earnest, it was realised that this assumption was mistaken, or, at least, one-dimensional, and that the soiling was rather more biological in nature, it was algae (pers comm, N Ashurst). It was unclear whether the cleaning regime was adapted to take account of this, or whether or not biocide treatments were deployed. Chemical cleaning proceeded.

It is most likely the case, of course, that the soiling is due to a combination of air and water borne particulates of atmospheric pollution as well as biological growth. Which came first, and which represents the primary soiling mechanism might be usefully investigated. As illustrated by the photograph above, the soiling is neither universally black nor green. Had a soot-generated patina already developed upon the outermost faces of the stones before the establishment of algal colonies? Has an original algal bloom acted to attract and to hold airborne particulates or aerosols? Have they always proceeded hand in hand? Are the species of algae present in a relationship with the types of pollution already present and will the dominant species change after cleaning given that the primary sources of atmospheric pollution in the area have changed?

Sandstones in urban or otherwise polluted environments develop a protective patina due to mineralogical changes near the stone surface which are a result of reactions between the components of the stone itself and pollutants. This patina is stable. Its removal can disrupt this stability and facilitate decay of the surface, at least until the patina reasserts itself with time, a process which may take many years. (Andrew, *Stonecleaning, A Guide for Practitioners* Robert Gordon University/Historic Scotland, Edinburgh 1994, P11*)*

The Doric temple is, indeed, much cleaner than the mausoleum. Clearly, and predictably, however, the algae and, it would seem, the soot is beginning to re-establish. It is also evident that the rinsing out of the chemical residues, presumably with water at high pressure, has left its own particular imprint upon some of the stonework, at least, in the form of wavy lines and stripes. Some soiling that was driven into the porous sandstone appears to be working itself back to the surface in less than attractive ways.

The Doric Temple. Re-establishment of soiling is well underway after 12 months, or else this is a re-emergence of soiling driven deeper into the stone during the cleaning process.

Chemical cleaners work by abrading the surface of the stone. The more porous the stone, the deeper they will penetrate and the more likely they are to linger beyond the rinsing out process. They can and will dissolve the matrix of sandstones, during and even after application. They may generally be anticipated to leave the surface of the sandstone more 'open' and coarse than before treatment. This openness traps moisture and organic debris, as well as algal spores, more readily than before, especially if the finish of the masonry was previously fine-honed and relatively uneroded. Unless the climatic or physical conditions that led to the original colonisation have changed, algae will quickly re-establish itself.

If a biocide is used, then the effectiveness of this relies upon its remaining in the stone: it cannot be rinsed out without negating its purpose. (If the biocide contains salts, then the imperative of longevity will bring its own problems). Once it has gone, algae will return. Treatment with biocide is not a 'one-off', therefore. It must be repeated regularly and often. Few biocides remain effective beyond the period of a year, and some for much less of a time. Many biocides contain salts that may cause significant damage over time to the surfaces of porous masonry. There are also serious considerations of health and safety in their use.

The blackening of the Doric Temple was likely a combination of soot and algae across most of the building. The pattern of decay in the sheltered underside of the dome, and particularly to the inner cornice, is the most dramatic upon the monument. Given the high exposure of the temple to the elements, this was the part of the building most protected from the falling and driven rain, and the only part that remained dry most the time. This pattern of the decay suggests progressive blistering and spalling of the stone in these areas. Such decay in such a location might be expected upon a limestone or a calcareous sandstone building, due to calcium sulphate crusting. This seems unlikely to be a factor here. In the absence of a calcium carbonate content in the stone, it may be that this area represented a drying zone for salt-laden water soaking through from behind the parapet at the base of the dome of the temple. The source of these salts may have been sulphate and nitrate rich aerosols from industrial emissions nearby.

Inner cornice and underside of the dome. Note the extensive algal bloom, as well as significant salt efflourescence. Clearly, water continues to penetrate the dome, carrying salts in solution and allowing algae to thrive. The source of the salts may be pollution; it may very likely be chemical residue (see Andrew, plate 5.3 p78)

Decay elsewhere is most likely attributable to the activity of ground-salts at lower levels. Ground salts rising into the masonry in solution during wetter conditions have crystallised just behind the face of these stones (breaking down the matrix of the sandstone, the suddenly unbound grains of silica falling away. The matrix so weakened by such cryptoflourescence leaves the stone eminently vulnerable to wind-scouring).

Doric Temple:
Decay caused by groundsalts in rising damp. Note the significant resoiling of windward stonework.

There is little evidence that the biological or chemical soiling of the Temple in itself has led to any significant damage or erosion.

There has been some stone replacement to the mausoleum and to the plnths of the obelisks in the relatively recent past.

Obelisk plinth

The chosen stone does not appear to be the best of matches for the original, lacking any apparent colour variation. It is not known quite how extensive was the erosion of those stones that have been replaced, whether their decay was structural, or whether lime mortar repair might have been appropriate as an alternative to complete replacement. The new stone has yet to blend in or to attract any significant soot or algae, certainly to that on the more directly exposed elevations of the monument. It would likely continue to stand out as new and 'different' even after cleaning. Millstone grits of similar character and appearance to the original stone of the mausoleum is available relatively locally.

The exact source of the sandstone of which both mausoleum and temple are constructed is said to be unknown. The particular sandstone of both is the same. It is a beige-buff colour with striations of a darker hue, tending towards orange. These colours come from the presence of iron. It is very likely, however, that the aggregate, as well as the primary binder of the sandstone at Wentworth is silica (quartz). Wragg states that "Stone had to be obtained from many sources- quarries at Wath, Mexborough, Denaby, Hooton Roberts, Burtcliffe Bank and, principally, from Oak's Quarry." It ought to be possible to discover the locations of some of these quarries, at least. In the meantime, and without laboratory analysis, the exact geology is currently unknown, but it may be confidently asserted to be a siliceous grit-stone, common throughout South and West Yorkshire. That is to say, a Carboniferous sandstone from the Millstone Grit series. The only quarry in South Yorkshire currently supplying such a sandstone is the Rivilin Quarry near Sheffield. There are many quarries in both west Yorkshire and Derbyshire supplying stone of similar geology. Its precise composition should be established before any cleaning regime is commenced, however, since this information should inform the cleaning option. The presence of any calcite/calcium carbonate, for example, would lead to serious damage to the matrix of the stone were acids to be deployed. Iron might be mobilised by certain cleaning systems, leading to unpredictable and unsightly staining. (It is possible that the darker beds now evident to the stonework of the Doric Temple is a consequence of such a chemical reaction with the cleaning agent deployed. There are relatively local stones available with such characteristics, however, in which case it might be pointed out that the replacement stone used in repair works to the mausoleum in recent times is not the best of matches for the original).

It is considered that the stone for the monuments was sourced locally to the estate, as presumably was that for the village of Wentworth, where the stones are much lower in the bed and somewhat darker overall. If they are geologically similar, which is likely, the stones of the more modest structures of the village, might be reckoned to have been won much closer to the surface, from shallower workings, less compressed, and more contaminated with iron, hence the more orange hue.

Significant erosion of local sandstone to the lower levels of a house in Wentworth village, illustrating the damaging alliance of salts carried in rising damp, salts splashed from the road and ordinary portland cement repointing.

Patterns of erosion in the village are locally quite dramatic, especially to the church, and especially at roadsides. This exponential erosion at lower levels of vernacular buildings in the village and particularly at the roadside demonstrate a paticular vulnerability to decay by salts. At the roadside, the source of these salts will be rising damp, but especially splash from salted roads. There may also be a vulnerability to vehicle exhaust fumes and, if this is the case, there may be some calcium carbonate content in the stone. It is likely, however, that the pitting of vertical surfaces is associated with salt contamination from aerosols of sadly now largely historic industrial pollution in the region. If so, the main source of such aerosols has now largely disappeared.

Roofless wall, Holy Trinity Church Wentworth village

Decay to the walls of the church is particularly severe to the walls of the ruined and roofless section, as well as to projecting details and carvings, demonstrating the enhanced vulnerability of regularly wetted sandstone to erosion by wind, as well as to probable salt activity, and to freeze/thaw cycling.

None of the stonework in the village is as extensively blackened as that of the mausoleum, however. This will have much to do with the specific form and location of the mausoleum, as well as to the perhaps softer and more variable consolidation of the inferior stone used for these vernacular buildings. The progressive break-down of the surface stone matrix leads to its steadily powdering away, taking deposited soot with it. Such a pattern of erosion is typical in calcareous sandstones and the possibility that local sandstones contain some calcite should not be ruled out. Simple testing of detached samples with hydrofluoric acid would establish this.

That the main component of the soiling is biological, and not a result of atmospheric pollution is not necessarily confirmed by an analysis of the soiling patterns of the mausoleum.

A limestone building soiled by airborne pollution, and particularly by carbon deposits, displays a characteristic pattern of soiling. Those areas regularly washed by water will be cleaner, even clean. Carbon particulates are rinsed away before they can form into crusts upon the surface by reaction with the calcium carbonate of the stone, forming gypsum. A leaking gutter, for instance, upon an otherwise blackened elevation, will lead to a clean, tapered strip beneath the break, where rainwater runs down the building. Generally, and especially in non-urban but nevertheless polluted environments, the greater soiling will occur in to those areas of the building that receive little or no direct or directed rain water. Typically, therefore, the undersides of window heads or cornices will be blackened and will readily develop blackened gypsum crusts. Those areas that are regularly wetted, especially in rural environments, will tend to be cleaner. The Rockingham mausoleum, of course, is built of sandstone, and *this pattern of soiling is reversed.* The main walls, as well as the exposed horizontal surfaces of the structure are black; the sheltered areas, from which rainwater is deflected by window hoodmoulds or cornices, are clean. The soiling attaches to those areas of the building that are regularly washed by rain, therefore, and does not find a home upon those areas that are not.

Most ‘normal’ buildings, such as those in the village of Wentworth, for instance, are built in a long and established tradition…they are detailed in such a way that minimises the wetting of the building; they have over-hanging roofs, gutters and down-pipes. Algae tends to get a foothold on the facades of such buildings only when a failure of detailing or of rainwater goods has occurred. Indeed, the development of algal blooms on most buildings is an indicator that all is not well and that a part of the structure is getting wetter, and staying wetter for longer than it should or as was intended by its builders.

A part of the church defended by roof and good detailing. Same aspect as the heavily eroded wall above.

A monument such as the mausoleum is different, however. The mausoleum stands alone, without the protection of either neighbouring structures or townscape. It is narrow and tall. Its narrowness affords little protection and means that its leeward elevations are little more defended against the elements than its windward. Rain-soaked wind will whip and eddy around the corners of the building. Furthermore, its tiered, ‘wedding cake’ design maximises the cascading potential of received rainfall and snow-melt, at the same time as its aesthetic allows for no gutters or down-pipes to gather and channel this water away from the walls below. The uppermost dome serves to distribute this rainfall quite evenly to the vertical elevations below. The mortar joints, which might evacuate some of this received moisture through evaporation, are tight. They may have been repointed with hard and impervious ordinary portland cement mortar in the past, denying even these tight joints essential vapour permeability. The duration of moisture in a structure is more critical for the successful colonisation by algae than its frequency. Once established, algae helps to keep the walls wetter for longer also.

The exposed location and design of the mausoleum also means that it receives ample sunlight. Algae are photosynthesising organisms that thrive on sunlight as well as moisture.

The obelisks are similarly, if not even more, hospitable to biological soiling. Angled faces are more readily wetted and absorb more received moisture, taking longer to dry out, therefore.

The location, design, material and the very aesthetic itself of the mausoleum, therefore, make it an almost perfect host for a thriving and vigorous community of algae, but also for the deposition of airborne pollution. The same factors that provide so welcome a home for algae also maximise the attraction of aerosol pollution. Aerosols- fine particulates and gaseous pollutants- are carried in the air and deposited upon buildings during rainfall. As the building dries out, the pollutants remain. The presence of algae will enhance their potential to linger.

Whilst the accumulation of soiling upon the wetter parts of the mausoleum is consistent with algal colonisation, it is also consistent with the expected soiling pattern of such a building constructed of siliceous sandstone, as is the apparently sound nature of the vast majority of the stonework:

“Quartz-based sandstones are very resistant to the sulphur-based acids in the air, but they can become very dirty. They tend to be dirtier in the rain-washed areas than in the sheltered parts of the building” (Honeyborne, *Weathering and decay of masonry,* in Ashurst and Dimes, *Conservation of Building and Decorative Stone, part 1, p157,* Butterworth Heinemann, Oxford, 1998)

The pattern of soiling to the mausoleum is as might be expected, therefore, in the presence of both algae and soot and is very likely to represent a combination of both.

None of the factors that have led to this will be altered by cleaning, and algae, at least, may be expected to return very readily. Indeed, abrasive cleaning will likely accelerate and enhance this soiling potential. All that may change is the exact composition of the colony, since species more tolerant of residues of biocide may gain an early foothold as these residues diminish in potency, and achieve a dominance they did not enjoy previously. These species may be more unsightly than the existing. Industrial pollution may be considered less of a factor now, but this fact means that the exact nature, character and appearance of the inevitable resoiling of the mausoleum will be even more unpredictable than it will already be under the influence of any chosen cleaning system.

The blackened appearance of the algae- insofar as this is the primary soiling agent- may be to do with the age of the colony, the dying back of some. It is most likely associated with the propensity of algal blooms to attract and to hold carbon particulates and other products of atmospheric pollution.

Clearly, that this part of Yorkshire has been the site of much heavy industry and that coal-burning, whether as a domestic fuel in nearby cities, or by steel mills and other factories, as well as by the coal-fired power stations that once abounded in the vicinity of Wentworth, cannot be ignored as a significant factor in the character of the soiling of the mausoleum historically. It *may* be the case that if the mausoleum was cleaned now, the inevitable regrowth of algae in the future would not be so inclined to black. It would, however, tend more to green.

Is there any evidence that either the algal colonisation or the products of industrial pollution are causing or promoting damage to the fabric?

Biological growth may be classed as a minor contributor to stone decay, especially when compared to other decay mechanisms such as salt contamination or frost, or the presence of ordinary portland cement mortars. Lichens may be considered to enhance the appearance of many buildings. The latter can cause pitting of some sandstones. Algae can promote the spalling of some sandstones.

As already mentioned, and as evidenced by extensive research and monitoring by Historic Scotland in recent years, the chemical changes that occur at the face of most sandstones in reaction with industrial pollutants tends to create a protective skin or patina which promotes rather than compromises durability. Disruption of this surface by abrasive cleaning of any kind can disrupt this benign effect, promoting and, indeed, causing decay that would otherwise not have occurred. The implications of abrasive cleaning (whether by blasting, chemicals, or even high pressure water) are unpredictable, to say the least.

The facades of the Rockingham Mausoleum are in a generally sound condition. There seems to be minimal decay to the stonework of the mausoleum itself. There is no evidence of water penetration to the interior of the monument. There has been some significant stone replacement to the plinths of the obelisks. The decision to replace these stones may have been a response to the generally crisp and uneroded nature of most of the stonework; they may not have merited replacement in themselves but have been simply more eroded by the effects of water run-off from the obelisks above. The obelisks were not an original part of Carr's design and were imported later from elsewhere on the Estate, for all that they add an extra dimension altogether to the aesthetic appeal of the monument. They may have been constructed of a different stone, or of stone from a different and less well consolidated bed part of the quarry.

There is little evidence, then, that the algae or soot is causing any undue decay to the stonework.

Algae can entrap moisture in the fabric of buildings constructed of porous stone, leaving them more vulnerable to frost damage and magnifying the deleterious impact of freeze/thaw cycling. There is little evidence of such damage to the mausoleum.

Moisture entrapment may lead to the corrosion and expansion of iron fixings within the masonry, seriously disrupting the masonry. There seems little evidence of such mechanical heave in the structure.

The blackness of the mausoleum will inevitably lead to its absorbing more heat from the sun and warming up more than might be expected were the building clean. The enhanced potential for thermal movement would be likely to contribute to the loosening of opc mortars in the joints, if such there was, accelerating the penetration of moisture, and its entrapment deeper in the building. There is no real evidence of this and it is anyway to be hoped that all mortar within the structure is lime mortar.

The expansion and contraction of the mucilage of algae during wetting and drying cycles *can* imitate freeze/thaw cycling and cause decay, but, once again, there is little evidence of this.

The impact of the soiling to the mausoleum, then, and whatever its exact make-up, is very largely aesthetic. It appears to have had a minimal impact upon the integrity of the fabric either as a whole or locally.

There would seem, therefore, to be very little structural reason to clean.

<u>Chemical cleaning</u>

As noted above, the Doric Temple was chemically cleaned some 12 months ago. The deployment of this option was based upon the mistaken assumption that the primary cause of the blackening of the monument was a result of atmospheric pollution. It would seem that the cleaning option was not amended upon the realisation that much of the soiling was, in fact, biological. It would seem that and that biocides were not used.

A test panel was cleaned with chemical cleaner in the past to the right-hand side of the door of the mausoleum. As of the time of our meeting, the chemical used was not identified. The appearance the stonework within this panel is grey and streaky and, to my eye, at least, quite displeasing. It is unevenly resoiling, either from the atmoshpere or by the migration to the surface of soiling driven into the porous masonry by pressure washing subsequent to chemical treatment, or both. Did the procedure return the stone to something like its original, quarried colour? How long did this colour last before turning this tawdry grey colour? There is little doubt in my mind that the blackened colour of much of the monument is preferable to this.

It is far from clear to me that chemical cleaning is ever appropriate to porous masonry. Chemical cleaning works by abrading and removing the immediate surface of the stone. It also soaks into the fabric of porous masonry and it is debateable, to say the least, how much of the chemical can be subsequently flushed out and how much remains. The current face of the mausoleum, for all that it may be cloaked in algae, is sound and patinated.

Experience, particularly in Scotland, has demonstrated that

"the application of chemicals will often interfere in a complex and unfavourable way with the manner in which the stone responds to natural weathering. The removal of a natural coating from a sedimentary rock such as sandstone has the effect of opening up the surface and of permitting a greater degree of water penetration. This will accelerate natural decay." (Cameron, Urquhart, et al *Biological Growths on Sandstone Buildings, Technical Advice Note 10.* Historic Scotland, Edinburgh 1997, pp34-35)

To quote further from Historic Scotland, an organisation that has devoted much time to researching the behaviour of particularly sandstones in response to cleaning:

" Summary of chemical cleaning methods:

"Chemical cleaning methods work by chemical reaction between the cleaning agent, soiling and masonry surface. Many different chemicals are used. Alkalis (commonly sodium hydroxide) or acids (commonly hydrofluoric acid) are frequently used. Alkalis are mainly used as degreasers prior to application of acidic cleaners.

"Hydrofluoric acid is capable of dissolving all minerals in stone and can be very damaging if improperly used. Problems include loss of mineral cements, grain loss, surface roughening, pitting, bleaching, staining and deposition of insoluble silica residues. Alteration to the porosity of the stone may also alter susceptability to algal regrowth following cleaning. Some retained chemicals may act as nutrients to algae and other organisms.

Pitting of stone to the Doric Temple. Was this present before chemical cleaning, or has it been caused by it? If the latter, is calcite present in the sandstone used? This pattern of pitting is typical of calcite loss due to acid cleaning (see Andrew, plate 5.1 p 75)

"Sandstones may retain a large proportion of the chemicals that are applied to them. Retention of sodium hydroxide may cause particular problems leading to effluorescences and accelerated stone decay as the sodium residues react with pollutants in the stone.

"Chemical cleaning can cause staining of the stonework by mobilising coloured minerals in the stone and redepositing them on the stone surface. Alternatively, bleaching may result from loss of coloured minerals from the stone.

"*Given the potential problems of chemical cleaning, its irreversible nature and largely unknown long-term effects, any decision to clean chemically must be carefully considered." (*Andrew, p96)

Biocide cleaning

The species of algae must first be identified, so that they might be targeted with the most effective biocide. The spores of most algae are highly resistant to most biocides and the survival of spores will accelerate future recolonisation. Biocides are most effectively deployed in dry conditions and after a period of dry weather, so that treatment is best carried out in summer. It is advisable to remove the worst of the algae with brushes before the application of the biocide, since thick surface growth or debris will absorb much of the biocide and prevent its absorption into the stone. Biocides must remain in the stone in order for them to perform their function. Once they have washed out (and algae grows on regularly wetted surfaces, of course, so biocides will inevitably be rinsed from the building over time), algae will tend to return.

"The effective lifetime of different biocides can vary widely, depending on the type of biocide, its concentration, the nature of the biological growths, the pH of the environment, temperature, microclimate, and the exposure of the treated area…(as well as) by the nature of the stone substrate" (p26)

Typically, biocides will endure between 1½ months to somewhat over 12. A programme of regular re-treatment will be necessary to keep the building clean: a significant expense.

Effects of biocides upon sandstones:

Biocides can lead to colour change in light-coloured sandstones. This effect is normally temporary, unless a copper compound has been used, but regular treatment would mean a frequency of 'temporary' colour change in vulnerable stones.

Some biocides will introduce salts into the building. Salts are a major factor in the decay of porous stone.

Biocides will cause mineral dissolution in some sandstones, promoting surface erosion.

The dominant species may change as recolonisation occurs, the biocide treatment providing windows of opportunity for species more tolerant of biocide residues. These new species may be more unsightly than those previously dominant.

It would be essential, prior to any regime of chemical or biocidal cleaning of the mausoleum, that the exact source and geology of the sandstone of which it is built be established and that the composition and porosity of a representative sample taken from the building itself is investigated. Similar diligence would be required in identifying the species of algae upon the building in order to select the most appropriate biocide.

Any cleaning system or approach carries hazards for the future decay and appearance of a building.

<u>Alternatives to chemical or biocide cleaning:</u>

Brushing.

If it is considered that the soiling has reached a point upon the soiling/weathering curve such that the level of soiling makes the reading of the building and its architectural intent impossible or difficult, or that the volume of algae has reached a point where its retention of excessive moisture within the fabric might be deemed a structural risk to the fabric, and in the context of the knowledge that the design, aspect and location of the monument means that algae will always tend to be present, then a one-off 'pruning' of the algae may be considered desireable.

The effect of such a procedure upon the pattern of soot staining must be taken into account, however. The removal of soot-infused algae might be expected to reduce the overall 'blackness' of the monument; it may reduce and dissolve away a proportion of the soot staining itself, but in the absence of more aggressive cleaning techniques, it would be unlikely to return the stone to a 'clean', fresh appearance. The colour would likely tend more to grey. Much, but not all of the green algal bloom might be removed by this procedure. Spores and algae would remain, however, as would the conditions for its regrowth.

Gentle abrasive cleaning with lower pressure lances and less aggressive blasting aggregate than generally used, might help in this regard, but any pressurised water cleaning system risks driving soot and other particulates deeper into the stone in solution. It will then remerge over time in unpredictable and certainly less regular patterns, giving the building a generally grubby and unsatisfactory aspect.

Dry and wet brushing is arduous and time-consuming. It is the least damaging of patina but could only be expected to deliver a reduction in the intensity of staining.

Dry-brushing of the stonework using stiff bristle brushes and fine stainless steel brushes ('lamb-chops' as supplied by Pine Brush Products, 01736 787420)) would be followed by the rinsing down and wet brushing and fine spraying of the building and finally by the more aggressive rinsing and chasing down of the debris with hoses. The objective would not be to remove all algae or staining. It would be important that the level of cleaning was even and that brush trails were not left upon the façade. Such a procedure might be carried out as part of a repointing and repair contract, if and when such works became necessary.

At the same time as such repair and conservation works were carried out, it might be considered appropriate to examine ways in which discreet improvements to the water-shedding capacity of the building might be made without compromising the aesthetic intention of its designer. More effective drips might be provided to protective leadwork above cornices to reduce cascading. It may be that mechanisms present at the time of construction have been damaged or compromised over time. Other drips might be introduced, by way of projecting courses of clay or stone tiles in strategic locations upon the elevations.

I would earnestly counsel, if the trustees are minded to clean the mausoleum, that they allow more time for the effectiveness and possibly unwanted consequences of the recent cleaning of the Doric Temple to be monitored and assessed before embarking upon any similar treatment of the Mausoleum.

It is essential to remember that chemical cleaning may damage the surface of the stones in ways that will make them more readily re-colonised by algae as well as potentially disfiguring the building.

Chemical cleaning is anyway, of course, unnecessary when the soiling is biological. Treatment with biocides alone would be sufficient, although pre-brushing and pre-rinsing would be required. It is important to remember, however, that cleaning with biocides cannot be a one-off procedure. The algae will begin to re-establish after a year or so and the process of recolonisation itself may not enhance the building. Treatment would needs be repeated on a regular basis. This would represent a significant on-going cost to the estate. Each treatment would bring with it all the potential disadvantages to the fabric and hazards to the environment and visitors as well as the operatives. The cumulative effect of such a programme of repeat treatments upon the fabric of the monument may be said, at the very least, to be unpredictable.

The use of biocides carries significant known and probably unknown health and safety risks for the individuals applying them to the building and to people and animals coming into contact with them subsequently.

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