100 YEARS AGO

Scientific critics in Berlin are now much exercised with regard to the remarkable performances of "Clever Hans," the thinking horse. According to the daily Press, a representative committee… witnessed these performances with the view of ascertaining whether they were the result of a trick, or whether they were due to the mental powers of the animal. Their verdict, it is reported, was unanimous in favour of the latter view. It is stated that when told that the day was Tuesday, and asked which day of the week this represented, the horse would give the correct answer by taps. Similarly he will tell not only the hour, but the minutes indicated by a watch.

From *Nature* 22 September 1904.

50 YEARS AGO

The decision of the Atomic Energy Commission… that Dr. J. R. Oppenheimer should be denied access to restricted data because, on the record before the Commission, he was not entitled to the continued confidence of the Government and of the Commission "because of the proof of fundamental defects in his 'character'" is, of course, a matter of domestic policy within the United States. Even had, however, Great Britain and the United States not been somewhat "mixed up" (Sir Winston Churchill's phrase) in the early development of the atom bomb, the termination in this manner of the Government career of one who had rendered such outstanding services in this field could not but be a matter of profound interest, if not concern, to scientific circles in Britain… Apart from the question whether even the most richly endowed nation can afford to divert an unlimited amount of its man-power to security investigations, the contrast between the ambiguous answers produced after so much voluminous inquiry and the swiftness and perspicacity with which Sir John Woods's committee investigating the Crichel Down episode in Britain reported on issues touching the public interest no less vitally is startling. Almost inevitably it suggests that there may be substance in what some American scientists are saying, and that Dr. Oppenheimer has been dismissed because his opinions were unpalatable to the authorities… who have chosen this retrograde manner of removing an adviser so as to minimize the possibility that others may avail themselves of his advice or services.

From *Nature* 25 September 1954.

Materials science

The art of restoration

David Erhardt

There are various techniques for the restoration of artwork — how effective and safe these are also varies. 'Reversible' gels could, however, provide a less risky way to reverse the ravages of time.

The cleaning of paintings is one of the most controversial activities that can be conducted in a museum. Unlike many artefacts, much of the value of a painting (both aesthetic and monetary) depends on its appearance, which in turn depends on the condition of its surface, especially the first few micrometres. The removal of dirt, yellowed varnishes and later overpaint is a critical step in the restoration of a painting, to return it to as close to its original state and appearance as possible. In *Langmuir*, Carretti *et al.*[1] report the development of 'rheoreversible' gels for the removal of non-original layers. These solvent-containing gels can be converted back to a free-flowing fluid state *in situ* for easier and more complete removal of the cleaning mixture. This work illustrates both the value of applying science to the preservation of artwork and the necessity of understanding the practical problems involved in determining the safety of any restoration technique.

The problem lies not in removing unwanted material from the surface of a painting, but in doing so without removing, disturbing or otherwise altering the original design layer. This can be extremely difficult, especially if the solubility of the overlying layer is similar to that of the paint binder (medium) — or, even worse, if the layer to be removed is less soluble than the original layer in any reagent. Traditionally, reagents such as solvents, spirits, alkalis, acids and soaps have been used, as well as simple mechanical action (scraping with a scalpel). More recently, scientific approaches have been brought to bear: solvent theory, explaining the action of solvents, has taken much of the guesswork out of preparing solvent mixtures of the desired strength; enzymes can remove very specific types of materials (proteases for proteins, lipases for oils, and so on). Lasers can simply vaporize the layer to be removed if it is otherwise intractable or if the original layer is too sensitive to other reagents; concurrent spectroscopic monitoring of the plasma plume of material removed by the laser indicates when the interface between different layers has been reached[2]. Still, the cleaning of paintings relies as much on the skill, experience and judgement of the conservator as it does on science, as any technique improperly applied can do damage.

In recent years, a number of gelled reagents have been introduced[3]. These polymer-based materials make it easier to localize the action of cleaning, to combine the action of otherwise immiscible components, and to avoid the problem of quick evaporation of volatile solvents. Unfortunately, much of the literature on these materials consists of anecdotal case studies that have not been peer-reviewed and which often contain unsubstantiated, even incorrect, statements regarding their safety, specificity, mechanism of action and the roles of the individual components. The safety of gelled reagents has not yet been adequately demonstrated, and even more serious problems than those with volatile solvents have been documented[4].

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Figure 1 **Brighter future? This fourteenth-century icon, held at the National Gallery of Siena, Italy, has become dulled over time. Tests on a small area (not shown) by Carretti *et al.*[1] suggest that 'rheoreversible' gels could be effective cleaning agents that would not damage the artwork.**

One major problem is the difficulty of completely removing the viscous gelled reagent and any non-volatile materials such as soaps or high-boiling-point liquids contained in the mixture. This is especially true when the material has been forced into cracks or a porous layer during the cleaning process. But Carretti *et al.*[1] have an ingenious approach: their gelled solvent mixture reverts to a free-flowing liquid on addition of a small amount (a few microlitres) of a weak acid solution (0.05 M acetic acid). The resulting 'degelled' mixture is more easily and completely removed than are viscous gels, in this case by absorption into a cotton swab. Further clearance of any remaining residue is facilitated by the fact that the gelling agent is now readily soluble.

Working on a small area of a fourteenth-century icon (Fig. 1) from the National Gallery in Siena, Italy, Carretti *et al.*[1] have demonstrated that their rheoreversible gels can remove material from the surface of a painting. The spectrum of X-rays absorbed by the removed material indicated that no mercury was present, which implies that none of the vermilion pigment (mercuric sulphide) of the original paint layer had been removed. However, removal of inorganic pigments is not often the major problem, because most are insoluble in the standard cleaning agents. More serious is the extraction of organic material such as organic dyes and pigments, or the low-molecular-weight compounds in the medium that function as plasticizers in maintaining the flexibility of the paint film.

Carretti and colleagues' infrared analysis of the removed material showed that the varnish was a natural resin. But infrared analysis does not find the minor amounts (relative to varnish) of paint media that are typically extracted. Infrared spectra of the common resin varnishes are quite variable, and also change with age, making the interpretation of resin spectra difficult to begin with, and the detection of minor components even less likely. Methods such as gas chromatography are much more useful in this context for evaluating the amount of paint media removed (with chromatography it is quite easy to look for compounds, such as fatty acids in oil paint, that are specific to the paint rather than to the resin). Similarly, infrared analysis of the cleaned surface cannot adequately demonstrate that no traces of cleaning mixture remain on the surface. Even scanning electron micrographs of the surface that show a surface similar to an uncoated paint film cannot unequivocally demonstrate that components of the paint film have not leached out.

The development and testing of new cleaning techniques and reagents for the restoration of paintings is a daunting task. Both techniques and reagents must be shown to be safe, causing no significant alteration of, or damage to, the original layers of the artwork. And this must be proved before advocating or promoting their use, which has not always been done by other researchers. Carretti *et al.*[1] have made significant progress in developing their new method, but much still remains to be done in evaluating the results and refining the technique to minimize any undesired effects. The rheoreversible gels developed by this team are a positive step in the development of gelled cleaning mixtures that are safer than those presently in use. The field should look forward to their further contributions on the subject. ■

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Environmental geography

Treeless at Easter

MARY EVANS

Easter Island in the eastern Pacific is one of the remotest spots on Earth, but distance need not lend enchantment to the view. When Easter was discovered by the Dutch explorer Jacob Roggeveen in 1722, he found it a treeless wasteland rather than the palm-fringed paradise one usually associates with the Pacific. Captain James Cook (writing in 1774) described the islanders as "small, lean, timid and miserable", hanging on as subsistence farmers amid the ruins of the giant statues erected by their ancestors (see picture).

The statues were erected between the eleventh and seventeenth centuries, and could have been the immediate cause of the islanders' plight. At its height, Easter Island society was based on a system of clans, who outdid one another in feats of megalithic excess. The strain cost the island all its native birds and all but a few of its native trees, which included the tallest species of palm tree in the world. Having turned their island's natural capital into artefacts, the islanders relapsed into war, savagery and cannibalism. In "Twilight at Easter", an article in *The New York Review of Books* (25 March 2004), Jared Diamond tells the story of Easter Island as a tragic parable for modern times.

But the islanders were, in addition, cursed by poor location. Elsewhere in this issue (*Nature* **431,** 443–446; 2004), Barry Rolett and Diamond present an analysis of environmental factors that might be associated with the deforestation of Pacific islands. They show that Easter had drawn a losing hand even before the first Polynesian colonists stepped ashore.

Islands most likely to lose their forests are small, dry, remote from other islands (and from continental dust inputs), low-lying and relatively distant from the Equator. Easter scores high on all these factors. "Easter's collapse was not because its people were especially improvident but because they faced one of the Pacific's most fragile environments," according to Rolett and Diamond. Or, in the words of the blues standard: "If it wasn't for bad luck, I wouldn't have no luck at all." In the final analysis, megalithomania was probably the last straw. Easter Island's current environmental profile cannot be wholly explained by natural factors, as Rolett and Diamond's model shows — and neither can the state of relatively well-wooded Pacific Islands such as Tonga, whose society employs its own protective measures against deforestation. **Henry Gee**