Conservation Treatments for Leather

by M A Yahia

FROM the remote past hides, first raw and then tanned, were used as a writing material by people of the Near East. Museum collections contain skin products of all kinds in all stages of deterioration but it is the task of the museum authority to take measurers for their preservation. Historical importance and archaeological conservation necessitated use of hot molten vaseline on wet leather and leather dressing on the dry of its kind. In order to justify the gradual development of the conservation of such leather, it is not out of place to mention the chemistry of leather which is most necessary to evaluate the process of archaeological conservation.

Composition and Structure of Leather

Leather consists of several layers of collagen fibers arranged in characteristic ways with triple helix complex structure. The arrangement of fibres also produces the grain pattern of leather which is micro-fibriol and is often clearly visible under the microscope. These complicated molecules of collagen tend to orient themselves in the same direction to associate in bundles and to retain water pertinaciously in a loose form of chemical combination. When the collagen fibres have been deprived of their water, the skin becomes horny and brittle. The flexibility of such brittleness can only be restored by relaxing the fibrous bundles, which is the case with dry leather. This relaxation could be achieved in several ways notably by prolonged manipulation or by the incorporation of lubricants or usually by a combination of both the processes. On the other hand hydrophilic quality alkaline soil water will accelerate the process because proteins in leather tend to be broken down in to their component amino acids by alkalies. In such circumstances, it is the archaeological conservator who to tackle the chronic problems.

Gradual development of conservation treatment for dry leather

The British Museum (BM) Leather Dressing for the treatment of dry leather was advised by Plenderleith who used the following composition: Anhydrous lanolin, 200 gm. Cedarwood oil-30 ml. Bees wax-15gm, Petroleum ether - 330 ml. This dressing improves the appearance of leather and in favourable environment, it softens the leather still further so that the leather may be moulded back to shape.

In the past, the flexibility of dry leather was recovered by impregnating the brittle leather with a material such as Turkey oil but this is not an entirely satisfactory procedure due to stickiness.

Four dressings were suggested by another scientist for application to leather. These are (a) 40% anhydrous lanolin with 60% Neats and Foot oil (b) petroleum USP (c) 3% Castroll soap with 12% beef tallow, 25% neats and Foot oil, 60% Distolled water and (d) 30% Anhydrous Lanolin with 5% Japan Wax, 12% Castor oil, 3% Sodium stearate 50% Dislled water. It was found that chrome leather resisted deterioration and the effects of the atmosphere better than the vegetable tanned leather. But all the mentioned dressings failed to protect the vegetable fanned leather effectively.

Ravage of museum property caused by red spot, a name to the chemical degradation, leads eventually to the total destruction of certain kinds of leather. There is no cure for this condition, believed to be caused by sulphur dioxide, but a method which enables affected objects to be saved from destruction has been investigated. John W Water mentioned Polyacrylate Resin which can be dissolved in Ethyl Acetate to a solid content of 24% but this solution is highly inflammable. For normal purposes it is diluted before use in proportion of one part of Plantex to three parts of Trichloro-ethane. Although flammability is reduced by this dilution, there is still danger and the usual precautions should be taken such as — good ventilation, open flame is prohibited; arching electrical apparatus can not be used, smoking is prohibited etc.

Waterer further mentioned regarding the use of British Museum Leather Dressing (BMLD) which seemed to offer some promise of longer life for a decaying object, but the lanolin did not provide a sufficiently positive support for any length of time. He therefore evaluated that Plantex should be applied, which would set in the form of a permanently flexible film in which the decayed and weakened fibrous structure could be firmly embedded and this could be easily dissolved out as and when such necessity arises in the future.

The methods evaluated by AEA Werner is wax. He mentioned three kinds of wax such as micro-crystalline wax, Polycthylene wax, Polyethylene Glycol (PEG). PEG is hydrophilic carbowax and he found promising results with the use of this wax. The particular grade chosen was carbowax compound 1500. This material is a blend of equal parts of the solid carbowax compound 1540 and a liquid polyethylene Glycol-300. At room temperature it has consistency of vaseline and melts to liquid at about 50°C. The disadvantage is that grade 1500 is hygroscopic to a slight degree, being about 30% as hygroscopic as glycol. When exposed to moist atmosphere the object assumes a sticky appearance but this should not occur under normal and preventive museum conditions.

Gradual development of conservation treatments for wet leather

Oil tannage makes leather water proof but leather is decomposed by catalysis when it comes in contact with metal. Tanned leather is not so easily destroyed. Bark tanned leather is conserved in watertight soil, dry calcareous ground, peaty soil whereas strong decomposition may cause in sandy grounds or rich earth. Leather will keep in the ground just so long as the PH — value is maintained around 6.4.

The problem of treating waterlogged leather objects was studied and a method was put forward by the laboratory of Swiss National Museum of Zurich.

The method developed was to treat with Methyl-Ethyl Ketone (MEK) followed by immersion in Carbon tetra chloride containing a fungicide (the oxide or Napthenate of tributyl tin). This process enables leather to dry out in flexible condition without undergoing shrinkage, and the object can be easily worked in to shape afterwards.

Another method is that immediately on recovery the material should be washed in several changes of cold water using disinfectant. The leather is then put to Cod-oil and tallow but leaves a sticky appearance and liable to harbour dust.

Also the leather, after washing in cold water, is immersed in successive baths of acetone until all the water has been removed. The material is then at once placed in a covered bath of BM Leather Dressing. Leather Dressing diluted with about 25% of the solvent used will continue immersion until the leather will absorb no more of the essential lanolin when usually a degree of flexibility will be achieved.

Crumpled skin in dry state should not be unfolded as it may crack irreparably. So it is dipped in water at room temperature and may be unfolded when it is sufficiently pliable.

But in order to remove water or to dry it, it is soaked in ethyl alcohol which in turn is substituted by a 20% ethylene glycol in ethyl alcohol solution.

This is a advantageous process.

Permanent pliability of the skin is achieved by the incorporation of a special soap which on drying loses its emulsifying property. so that it no longer promotes absorption of water in the skin. This soap is used in leather industry in the flesh side for stuffing process as an additive.

In the treatment of wet leather with Carbo-wax-1500, it has been found that it sweats when it is used alone. The reason being that the PEG 300 is very hygroscopic. However this may be achieved when it is used in conjunction with vinamul. This is probably due to two factors (i) the carbowax is present in low concentration in leather (ii) the vinamul is sealing the PEG in to the leather and protecting it, to some extent from the water vapour.

The Polyvinyl Alcohol cross-links and the Glycerol is hygroscopic. As a result when 100% glycerol is used, there is a risk of sweating in high relative humidity. At a RH of 100% it sweats sufficiently and cannot be used but this method could be used as a field treatment as it is reversible.

viii) PEG-1540 gives a very acceptable degree of shrinkage with no problems of taking care but it does have the serious drawbacks of lack of flexibility, dark colour, difficulty with surface cleaning Carbowax-1500 and 750 are only suitable if air-conditioned storage is available. Apart from flexibility, they have advantage over carbowax-1540 and have the disadvantage of stickiness. All the treatments are readily reversed by washing with water.

Ferromede-113/10% Bavon was very promising. Its disadvantage being the high shrinkage of 11%. It treated in small lots, it would take a very long time and if it has done at once it would require a large quantity of Ferromede and present a considerable fire hazard. It has the advantage that it is cheap.

Simple dehydration by alcohol is not acceptable mainly because of the very high shrinkage. Alcohol soluble Nylon is not a good process owing to the reason that leather is curled up and it becomes very stiff.

Wet leather can be treated by Freeze Drying Technique after impregnation with PEG 400 solution of 10%-15%. As it is possible to obtain soft leather by removing water, for instance with acetone, it seemed that it could also be removed by freeze drying.

The leather is treated in the same way as the wood from the excavation. It was found that it could be stored in the deep freezer without any fungicide before PEG impregnation with no danger occurring. It usually needs two weeks for impregnation in PEG 400 and then after at least 20 hours in the deep freezer. It is rapidly dried in the vacuum chamber. The loss of water is usually 60%-75%. Very fine leather objects are cleaned by immersing in water and applying ultrasonic vibrations. It is however possible to brush off sand and dirt after the freeze drying, if a correct concentration of PEG 400 has been used. The dimensional shrinkage varies and obviously depends on the kind of leather, the method of tanning and the state of degradation.

Both the treatment of wood and leather by the described method is reversible. If the look of the objects is to dark indicting a surplus of PEG 400, this can be leached out with water and the process repeated with the correct concentration. Cracking caused by too little PEG 400 is not easy to repair, but it sometimes seems to increase the amount of PEG 400.

It is evident that a considerable development on conservation for both kinds of leathers is underway. Particularly, the use of PEG for dry leather is quite satisfactory.

On the other hand, several processes for wet leather has been developed. Mention may be made for Freeze Drying Process, although this has not been widely used in all the laboratories. Many scientists working in this field believe that this freeze drying method will meet the challenges of conservation of leather in future.

(The writer is an archaeological chemist)

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Engineering Plants to Resist Pests

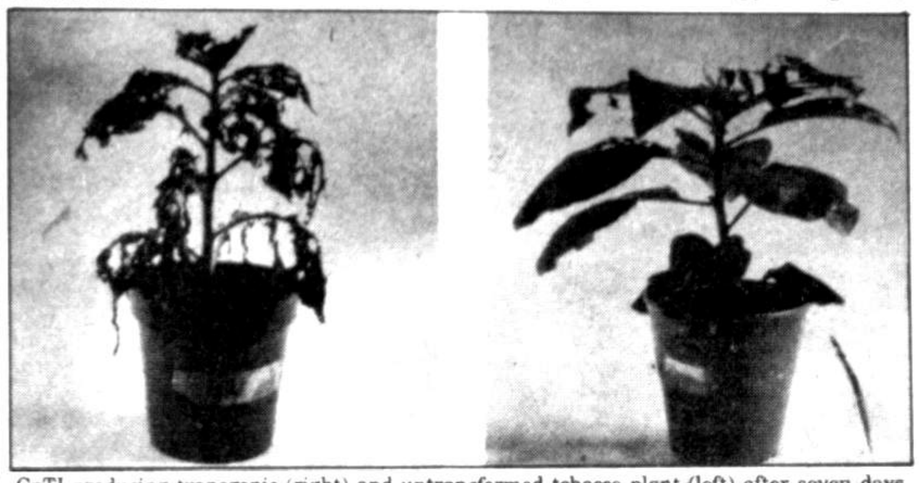
FORECASTS of population trends suggest that, while food supplies will increase by 1% annually, the number of people in the world will increase at the faster rate of 1.7% a year. Furthermore, in the past insufficient attention was paid to the long term impact on the environment of modern intensive agricultural practices.

Allegations of pollution from excessive spraying of chemical pesticides is a major criticism of industry in campaigns for protection of the environment by conservationists.

But some form of pest control is essential. An abrupt halt to the use of chemical pesticides would have serious consequences for world food supplies. Pests destroy 13% of crops either in the field or during subsequent storage; hence, there is an urgent need for alternatives to traditional chemicals.

There are several options, but the improvement of pest resistance of plants through a modern plant breeding programme of genetic engineering is by far the most promising.

Previous efforts for reinforcing insect resistance by classical plant breeding has in the past only been partially successful; thus, the need to retain chemicals.



CpTI producing transgenic (right) and untransformed tobacco plant (left) after seven days exposure to tobacco budworm caterpillars.

Moreover, the established methods of cross-breeding are slow processes, taking up to 15 years to produce a new variety.

Heightened resistance

Genetic engineering is of greater assistance to breeders since it provides access to a much larger gene pool, is faster and allows for the 'pyramiding' (combining) of genes from various sources more easily.

The advances in recombinant DNA technology, on which genetic engineering is based, enables the transfer of genes between different types of plants and between micro-organisms and crops.

The new varieties containing the transplanted genes are classed as transgenic plants, if the new characteristics conferred by the donated gene or genes transferred are stably expressed in subsequent generations.

Transplanting genes

There are several ways of creating transgenic varieties either by splicing a naked segment of foreign DNA (a gene) into the plant's chromosome, or by, first, incorporating the gene into a bacterium which acts as a carrier. Bacteria are then inoculated into the target plant, taking the gene with them.

In practice, the DNA segment or bacterial vector is incubated either with plant cells or with pieces of plant tissue which are then regenerated into whole, fertile plants carrying the new genetic information. Recent successes involve injecting the DNA into whole plants either with microsyringes or by shooting with DNA-coated projectiles.

Most experiments exploit the soil bacterium *Agrobacterium tumefaciens, Ag tum.* In nature this bacterium causes Crown Gall disease by a process which is, in effect, an example of natural genetic engineering.

A small piece of the DNA of *Ag tum*, call T-DNA (tumour DNA), is transferred from the bacterium and incorporated into the genetic material (chromosomes) of the host plants.

The plants then express the bacterial DNA (genes) so giving rise to the disease symptoms.

When employing a micro-organism deliberately as a vector, the bacterium is at first 'disarmed' by deleting the tumour-forming genes and replacing them with useful genes.

All other functions of the genetic vector are unimpaired and in this way useful 'foreign' genes are incorporated into the healthy host's chromosomes and stably expressed in subsequent generations.

There are various advantages of genetic engineering for insect resistance, compared to chemical control. Crops are given season-long protection which is independent of weather conditions. Plant tissue is protected that would otherwise be difficult to reach with sprays. So the protection is confined to plant tissues and only crop eating insects are exposed to the active factor, which is biodegradable and usually non-toxic to man or in animal husbandry.

Sources of resistant genes

Plants have come to possess a wide variety of natural protectants in the course of co-evolution of insects and flowering plants over millions of years.

Prominent among these compounds are proteins such as enzyme inhibitors and lectins. They are the products of one or a few genes and therefore ideally suited to this method of gene transfer.

Important plant proteins with known insecticidal properties, demonstrated in bioassay or with transgenic plants, are listed in the table on the following page.

Research at Durham includes two examples of transgenic plants produced by genetic engineering which show enhanced insect resistance under field conditions. One incorporates a bacterial gene which normally regulates the generation of a toxin by *Bacillus thuringiensis (B thur).*

B thuringiensis formulations have been used successfully as an insect crop spray for many years. On sporulation the bacterium produces a crystalline protein which, when ingested, formed toxic fragments in the insect gut, so disrupting the function of the gut membrane.

Recently, insect resistant transgenic plants containing modified *B thur* genes, and expressing the *B thur* toxin, are showing field resistance in both transgenic tomato and cotton plants.

The second example is the use of cowpea trypsin inhibitor (CpTI) to enhance insect resistance in crops. This is an example of a protein protectant occurring naturally in one species of crop plant, being transferred to another by genetic engineering.

These examples illustrate one strategy for engineering insect resistance into crops, starting with a biotype of any origin displaying field-resistance to insects. It is then subjected to biochemical factionation, with testing of isolated fractions by bioassay until a pure protein component with relevant anti-pest activity is identified.

Next, the combination of amino acid molecules forming the protein is determined. With that analysis a search then follows, in a gene library obtained from seeds of that variety of plant, to pinpoint the appropriate segment of DNA which would comprise the genetic code for the synthesis of the protein.

This gene is then modified (engineered) so that it can be inserted into an *Agrobacterium* vector and will be expressed once incorporated into a host plant. Transgenic plants so produced are challenged with larvae of pest insects to demonstrate enhanced resistance to the pest.

The CpTI protein gives a wide range of protection not only against Lepidopteran pests (caterpillars, moths etc) such as *Heliothis* and *Spodoptera*, but also against Coleopteran pest (beetles) such as *Callosobruchus* and *Anthonomus* and also Orthoptera (locusts, crickets) such as *Locusta migratoria.* In fact, this may be a general characteristic of natural protein protectants.

Public Perception

There is little doubt that genetic engineering of plants for insect resistance is an achievable objective. However, the development of the technology depends on factors partly outside the scientist's control; for example, the attitude of the general public to genetic engineering is, on the whole, negative.

There is an urgent need for a proper regulatory framework, so technology can be developed responsibly without imposing unnecessary constraints on industry. There is also the need to reassure the public that the benefits will vastly outweigh any possible disadvantages.

The concern of the public is understandable and any possible ecological risks must be investigated cautiously and openly. The ecosystems in which transgenic crops will be grown are man-made, 'artificial' agriculture systems, in which the species present are pre-determined and are subjected to various agricultural practices.

Accordingly, ecologists believe that transgenic plants will not compete successfully with natural weedy relatives in adjoining ground, but very little data is available on this aspect of genetic control.

Recently, however, a European Community programme called PRO-SAMO (Planned Release of Selected and Modified Organisms) has yielded important results. Seeds of *Brassicanapus* (oilseed rape) sown in uncultivated land yielded plants which failed to set any seed at all.

But this was equally true for trnasgenic plants containing a herbicide resistance gene and for untransformed rape. Furthermore, pollen from these plants only traveled about 12 metres and no hybridisation with the wild relative, Charlock (*Snapsis*) was recorded; i.e. not only were the plants uncompetive but the genes themselves stayed put.

Thus, in this case, disaster scenarios such as that conjured up by the spread of the exoticprickly pear in Australia, are not appropriate.

Insect resistant transgenic plants are one product of biotechnology that could really help the less developed countries, where the ravages due to insects are at their worst.

It is important to stress that engineered resistant plants are 'user friendly', since they are handled in exactly the same way as conventional seeds.

There is also a need to agree ways in which the property rights of industry are protected so that essential research and development continue, but at the same time benefiting third world countries. One way forward has been taken by the Rockefeller Foundation in its international Rice Biotechnology Programme, which has changed rice in a few years from a biotechnologically neglected crop, to one at the cutting edge of research.

Another example is CpTI, where the company which funded the isolation of this gene has agreed to make it available to the Institute of Tropical Agriculture, Nigeria, which helped in the initial stages of the CpTI programme.

— Spectrum

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Research Beefs up Tuberculosis Test

AUSTRALIAN beef producers will save millions of dollars a year thanks to a tuberculosis diagnostic kit developed jointly by Commonwealth Serum Laboratories and CSIRO.

In 1970 a programme financed by government and the beef industry was set up with the aim of eradicating brucellosis and tuberculosis from Australia's beef herd by 1992.

Almost a billion dollars had been spent on the programme and Australia was declared free of brucellosis in July 1989. But tuberculosis has proved a greater challenge, especially in remote northern areas.

Eradicating a disease requires accurate diagnosis, but the standard skin test for tuberculosis had some major short comings. It involved injecting the animals and then holding them for three days for assessment.

Repeated mustering and testing were required to counter false results, making it expensive in remote areas.

The inaccuracy of the test meant that many cattle were slaughtered unnecessarily, while others showing false negative results continued to pass on the infection.

After several years' research on a blood-based test for tuberculosis, the Bovine Tuberculosis Research Group in the CSIRO's Division of Animal Health, led by Dr. Paul Wood, approached CSL to develop a commercial diagnostic kit.

A test kit was perfected after two years of collaboration between CSL and CSIRO. John Cox, the head of immuno-diagnostic R&D at CSL when the kit was developed, says: "The intellectual innovation was CSIRO's but its conversion in to reality was very much a joint venture."

The blood-based test is simpler and more accurate than the skin test and can provide results within 24 hours.

The only complication is that, unlike the skin test, which is done in the field, the new test must be performed in laboratory.

The test involves detecting a hormone, gamma interferon, which is released by white blood cells of infected animals when a small sample of their blood is mixed with a tuberculosis antigen.

John Cox says one of the big advantages of the gamma interferon test is that there is no limit to how often or when it can be used.

In contrast, after undergoing the skin test, an animal can not be re-tested for at least 60 days.

Preliminary field trials were held with a prototype kit in 1988 and a commercial version was tested on more than 13,000 cattle in all states and the Northern Territory in 1989 and 1990.

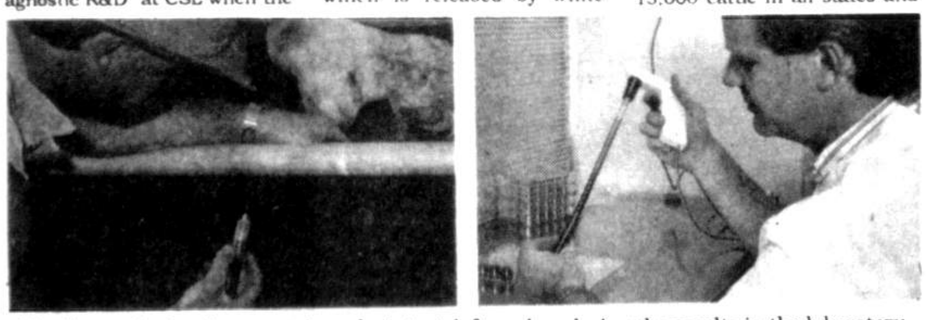
The new test was found to be significantly more sensitive and specific than the old method.

CSIRO has given CSL an exclusive licence to manufacture and market the kit worldwide. CSL has sub-licensed to IDEXX Corporation in the US.

The technology used in the test is already being adapted for the detection and prevention of other cattle and sheep disease as well as the detection of certain infections in humans.

The project group was awarded the coveted CSIRO Medal in November last year. Chief of the CSIRO Division of Animal Health, Professor Mike Rickard, says: "This project is an outstanding example of how research scientists can act as product champions and assist their commercial partner by taking the results of their research through the process of technology transfer and in to the marketplace."

— Australian Science



Bleeding cattle for the new tuberculosis test, left, and analysing the results in the laboratory.

Duckweed Potential Gold for World's Rural Poor

A prolific weed could improve the environment and health of poor communities throughout Asia and elsewhere.

The common "duckweed" (Lemnacaca) purifies wastewater contaminated by excreta. It has a protein content similar to that of soya beans and it can be sold as a cash crop for fattening fish and feeding human populations.

Duckweed grows prolifically at water temperatures ranging between 15 C and 30 C. In wastewaters rich in nitrogen, phosphorus and potassium, the vibrant green plant with its tiny leaves can double its weight every two to four days.

An American-based non-profit organisation known as the Prism Group has been experimenting with patented duckweed systems in Peru, Mexico, Bangladesh, Egypt and the United States for a number of years. Its chairman in Bangladesh, Mohammad Ikramullah has described it as "green gold."

In Bangladesh, where 97 per cent of the population is without sanitation services and where half of all surface water is contaminated by fecal matter for half the year, the cultivation and harvesting of duckweed has enormous potential.

Mr Ikramullah reports that wastewater treatment systems covered in duckweed can produce crystal clear water with a phosphorus and nitrogen content of less than 0.5 milligrams per litre within 20 days. "It is purer than the purest surface water," he says.

During the purification process, the weed can be continuously harvested to yield one ton per hectare per day and sold retail for US$ 27 a ton.

Duckweed can triple average yields when fed to fish but it can also be dried and added to chicken feed. "It is a fabulous feed for fish," says Mr Ikramullah. "It is fantastic for treating and it is obscenely profitable for farmers."

Prism-Bangladesh has been experimenting with carp raised in ponds where freshly harvested duckweed is the only source of food. The ponds yielded more than 10 tons of carp per hectare per year compared with just 400 kilograms under traditional aquaculture. At an average price of US$ 2 per kilo of fish, the net return is about US$ 16,000 per hectare per year.

The United Nations Capital Development Fund of the UN Development Programme (UNDP) is currently supporting the introduction of Prism's duckweed technology to 10 villages in Central Bangladesh.

Farm families will be encouraged to channel their wastes in to derelict ponds surrounding the villages where it will fertilise the cultivation of duckweed by individual farmers on one-quarter hectare "plots."

Weed production is so vigorous under these controlled conditions that a quarter hectare fed by effluent from about 100 people cab be a full time job for one farmer and generate more income than an equivalent-size plot of rice.

It has been estimated that Bangladesh has some 500,000 hectares of derelict wastewater ponds throughout the country which pose extreme risks to health. Although 80 per cent of Bangladeshis have access to safe drinking water most use polluted village ponds to bathe and wash their clothes.

"About 28,000 tons of human waste are disposed of every day in the public domain in Bangladesh," says Philip Wan, head of the UN Children's Fund's water and sanitation activities. "This is a major environmental threat."

They are harvesting and marketing it as a salad in health food shops across Europe. — Depthnews Asia.

'It is fantastic for treating wastewater and it is obscenely profitable for farmers.' It can also triple average yields when fed to fish.