STUCK PAGES SLICED APART WITH ENZYMES

A New Type of Scalpel

by T. F. NIELSEN

DOCUMENTS and books printed on art paper become glued together when water damaged. In past years professional conservators and restorers have concluded that the task of restoring items on glossy art paper was impossible, as within a few hours of being exposed to water this type of material always becomes a compact block that cannot be separated safely. The reason for this is the casein adhesive present in most art papers, which has completely resisted attempts to separate pages. No available literature seemed to give any clue to a safe restoration method.

Most art paper is a thin tissue of plant fibres (cotton or wood) with a variety of sizes used for the surface. These sizes are used to make the paper more suitable for writing, by making the surface harder and less penetrable to inks. Animal glue was a commonly-used size, and later resin and aluminium potassium sulphate came into frequent use. In an attempt to improve the paper fillers, mineral pigments such as china clay and kaolin were also added and a variety of coating methods developed. Adhesive casein with mineral pigments is the most commonly-used coating agent: about 90% of art paper contains casein, the remaining 10% using a variety of other proteins and synthetic materials.

Early experiments to 'unstick' art paper included the immersion of the paper in substances which lower the surface tension of water, and immersion in foam-producing solutions such as hydrogen peroxide. Unfortunately, most of these experiments did not solve the problem and, in the process, they usually completely ruined the pages.

In 1972 when on a Fellowship to Italy, the United Kingdom and Scandinavia, I became interested in this problem and I have since maintained the interest and a correspondence with a number of people working on similar lines. But it was not until a couple of years ago that I heard of the work of a Norwegian librarian-chemist, Mr Oystein Wendlebe, who was doing some excellent work in this field. I have since done some work myself along his line, and I have found that his method works wonders—and indeed completely solves the problem of glued-together art paper.

Here I am more or less quoting Mr Wendelbe's words. The idea of using the enzyme *Trypsin* came to him at the 32nd Nordic Congress of Internal Medicine. He had tested a variety of other enzymes without success; but at one of the display stands he inspected a new preparation for the removal of debris from wounds. This preparation included the enzyme trypsin, and it struck him that the same enzyme might be able to digest the protein coating, largely consisting of casein, in art paper.

Casein glue is readily split by the enzyme trypsin as it contains amino acids, argine and lysine. The trypsin hydrolises peptides, amides, and esters, the bonds containing the carboxyl group of argine/lysine.

Just as a scalpel can be stopped at will by the operator, so the enzymatic action can be stopped immediately. This is done by placing the materials into a cold water bath, because the enzyme trypsin needs considerably higher temperatures to be able to perform its functions.

The enzyme approach seems to be the answer to many a restoration problem which until now has seemed insoluble. Enzymes are part of a varied group from which one may be chosen to deal with a specific problem while leaving the many other structures in the material untouched. The second, equally important, advantage of enzymes is the speed of this process. A job that takes other chemicals days and weeks, mostly with some damage to the article, can be achieved in minutes without damage using this process.

The procedure of this enzymatic method is fairly simple. As crystalline trypsin is quite an expensive item, a technical preparation called Pancreas Trypsin Novo is used. This contains trypsin and chymotrypsin only, apart from enzymatically-inactive protein and amonium sulphate. The enzymatic preparation, activity 6 Anson units per gram, is dissolved in Sorensen phosphate buffer solution with a pH of 8.0. (Pancreas Trypsin Novo is active at pH levels between 5.0 and 11.0, with the maximum activity at 8.0). The temperature of this solution must be kept at 40°C (plus or minus 1°), and this can be done by using a hot water bath. For most purposes this temperature gives the ultimate combination of activity and stability.

The paper is placed in this solution and the casein starts to dissolve immediately. The text usually emerges within five to ten minutes, and the separation can be aided by a fine, blunt spatula. The enzymatic effect is stopped by washing out in ordinary tap water, and the pages are dried and flattened. The same procedure has been used very successfully in extracting papyri from grease cartonnage, a material used by ancient Egyptians for mummy-casings, made of linen cloth fixed with glue-stucco.