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Editor's Note

In the latest issue of RESTAURATOR (Vol. 6, No. 3–4, 1984), the Publisher informed you of the change of editorship for this journal. As Editor-in-Chief, I have taken over from Poul A. Christiansen, its founder and mentor, the task of continuing his work and the struggle for its high aim – an aim which results from the fact that RESTAURATOR is the only international journal specially and exclusively dedicated to library and archive conservation and restoration or, better, to the scientific background, history and research of these activities. This dedication, as I understand it, is a special duty and responsibility.

By reading RESTAURATOR regularly, the archivist, the librarian, the restorer should be informed, albeit not in full detail of all that is happening in the field. This cannot be presented by one single journal and an Editorial Board of limited membership, even though its members come from those (and all those) countries which are specially active in the field.

However, a librarian, an archivist, a restorer reading RESTAURATOR regularly will be informed in all areas and directions in the field, and he will find convenient access to further special information. The field RESTAURATOR is dedicated to is of increasing interest. Alarmed by the millions of books, files, documents, works of art on paper, parchment, etc. endangered by loss, more and more custodians of the larger collections in any country become aware of the fact that these objects are fragile items susceptible to damage and decay; that this tendency is a condition of their existence and that man, having produced them, must permanently care for and be active in preserving them. Conservation is becoming quite popular. RESTAURATOR will continue to contribute to this increased interest by supplying information based on science and knowledge.

Conservation, preservation, restoration or, correctly, their intellectual bases, are very apt for international cooperation and exchange. The managing, manual and actual work is, of course, the business of single collections, i.e. individuals and teams.

International cooperation and exchange of information is, among other things, a problem of language. From Vol. 7 on, RESTAURATOR will publish all articles in English, with summaries in French and German. Manuscripts written in other languages and subsequently submitted in French or German, appropriate for publication are accepted, and will be translated into English by professional translators. These articles, in turn, will be reviewed for technical

correctness by the authors of a relevant article. Anyone active in the field is, of course, well able to understand precisely any technical text in the international medium, even if he is unsure when using it for writing. But by this combination of professional translation and technical revision, linguistic and technical misunderstandings will primarily be avoided.

With the assistance of active colleagues within the Editorial Board, I hope I can fulfil what I have promised: i.e. in addition to the above, to realise a regular quarterly publication of RESTAURATOR with qualitative articles and intellectual and practical applications of international scope to the pressing and vital problems in this field.

Helmut Bansa
Institute for the Restoration of
Books and Manuscripts of
the Bavarian State Library
Munich

The Effect of Disinfection with Quarternary Ammonium Salt Solution on Paper

by A. B. STRZELCZYK & J. ROŻAŃSKI

Introduction

In the conservation treatment of paper antiquities infected with mold, disinfection is of primary importance. Many methods have been used for this purpose.[1] Fumigation with ethylene oxide[2] and with other fungicidal vapors, such as *p-chlor-m-cresol* or dichlorophen has been employed.[3]

Disinfection with ethylene oxide of single prints, maps or books requires expensive vacuum chambers, which are usually not available in small conservation laboratories. Therefore a simple chemical treatment, which can disinfect paper artifacts without degrading them, would fill a long-felt conservation need. Such a method of disinfection by a quarternary ammonium salt (*quas*) solution bath was performed in our laboratory.[4] In this method, Sterinol (10% water solution of *dimethyllaurylbenzyl ammonium bromide*, POLFA, Poland) is used. It was found that a 15 min warm bath containing 0.75–1.0% of the above mentioned pure ammonium salt causes effective disinfection of the most badly molded paper objects (black/white) such as book sheets, prints, maps, etc. This technique easily removes dirt and fungal deposits from paper. The surface active properties of this compound were considered. After the disinfecting bath in the above ammonium salt solution the disinfected material should be thoroughly washed with tap water and subsequently 3 times with distilled water.

It was mentioned by Browning[5] that quarternary ammonium compounds are used for disinfection of paper pulp during milling and also for protection of the final product against the development of microorganisms. The concentration of these compounds in the paper may reach 0.5%. Sykes[6] found that these salts are especially easily adsorbed by materials of well developed surfaces like paper, charcoal, etc.

Triolo et al.[7] studied the effect of Cequartyl BE (*lauryldimethylcarbetoxymethyl ammonium bromide*) on paper. They stated that the above compound induces a dangerous acidity of the paper (pH 4.8). Cequartyl BE introduced into the paper in a concentration of 3% caused an unfavorable decrease in the degree of cellulose polymerization, although it did not appreciably affect its brightness. The neutralization of a Cequartyl BE solution with sodium hydroxide diminished this harmful effect. The above authors are of the opinion that the com-

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pound remaining in paper may affect softening of printing inks and the transfer of these media on neighbouring sheets in books during their storage.

The results obtained in our laboratory (unpublished data) have also shown that the residual *quas* in treated, but unwashed paper accelerates its degradation upon aging. A marked decline in its physical properties is observed upon accelerated aging.

The purpose of our work was, therefore, studying:

1. the effect of disinfection bath in *quas* solution on physical properties of the paper,
2. conditions of elution of this compound from the paper,
3. the influence of the residue of *quas* on the properties of paper after accelerated aging.

Table 1. Combinations of paper washings prior and after disinfection.

Combination	Washing		Disinfection bath in *quas**	Washing		Drying
	Tap water 30 min	H_2O dist 3 times		Tap water 30 min	H_2O dist 3 times	
I	–	–	–	–	–	–
II	+	+	–	–	–	+
III	+	+	+	–	–	+
IV	+	+	+	–	+	+
V	–	–	+	+**	+	+
VI	–	–	+	+***	+	+

* – 15 min in 1% quas solution (50°C).
** – all sheets washed together.
*** – each sheet washed separately.

Material and Methods

1. Studies on the influence of quas *on physical properties of the paper.*

Dimethyllaurylbenzyl ammonium bromide (Sterinol) was used in this research. This compound is easily available and not expensive. It is commonly used in medicine as a disinfectant.

The experimental material was Whatman's No 1 filter paper. The paper was disinfected and washed as shown in Table 1.

Subsequently, samples were taken from these sheets and climatized (24h, 20°C, 65% RH). The following physical properties of these samples were determined: breaking weight in Schopper's apparatus according to the Polish norm (PN 78/ P-50080) and tear resistance on the Elmendorf apparatus (PN 62/ P-50080-82). Ten replications were used for each direction of the paper. In order to study the elution of the salt from the treated and washed papers (combinations II-VI) the content of this salt in paper was determined.

The possibility of *quas* elution from the molded and from thermal-aged paper (6 days, 105°C in TWIST OFF glass jars) disinfection according to combination VI (Table 1) was also studied. The aim of this experiment was to prove the capability of *quas* elution from deteriorated paper of a high degree of cellulose degradation.

Quantitative determinations of *quas* residue in the paper were carried out according to the method adapted to our studies. It was based on the methods published by Browning[5] and Korenman.[8]

Determination was carried out as follows: a) the sample of paper about 1.5 g was mixed in a Waring blender; b) to 1.0 g of the mixed paper, 80 cm^3 of 1 N HCl was added and vigorously shaken for 10 min; c) this was poured into a small column, and d) the eluate from the column was collected to an amount of 100 cm^3 by washing with 1N HCl. It was stated previously that from this amount about 94.8% of *quas* introduced to the column with the paper is to be obtained. The quantity of *quas* in the eluate was detected as follows: to 1 cm^3 of the eluate, 5 cm^3 of 2N KOH and 5 cm^3 of 10^{-4} M dithizon in chloroform were added. After vigorous shaking the sample was left for a while for separation of layers. In the chloroform layer the optical density in the spectrophotometer SPECOL (Carl Zeiss, Jena) was determined using a wave length of 500 nm. The stability of the coloured *quas*-dithizon complex takes about 30 min and at that time the determinations were done.

2. Studies on the effect of the quas *residue on the paper after thermal aging*

The following paper samples were used:
1. washed during 10 min with distilled water,
2. as above and aged during 6, 17 and 35 days,
3. disinfected in 1% *quas* solution for 15 min,
4. as above and aged during 6, 17 and 35 days,
5. as in sample 3 and treated with a series of washings (AI-AIV) and aged for 17 days.

Paper sheets of a proper combination were washed together to avoid the elution of a whole amount of *quas*.

Conditions of paper aging: the dried paper sheets were cut into samples adequate to the determination of chemical, optical and physical properties of the paper. After climatization the samples were closed in TWIST OFF glass jars and aged at 105°C. Experiments were done in duplicate.

After aging, the samples were climatized and thereafter the following studies were performed:

a. changes of the degree of whiteness (in % – PN 68/7308–9),
b. pH of hot water extracts (Browning[5]),
c. alpha-cellulose content (Browning[5]),
d. breaking weight (PN, as above),
e. tear resistance (PN, as above),
f. residual *quas* according to the above mentioned method.

These studies were carried out on samples specified in no. 5.

Table 2. Conditions of paper washing after disinfection.

Combinations	Tap water (min)	H_2O dist.
AI	–	3 times
AII	5	3 times
AIII	15	3 times
AIV	30	3 times

Results and Discussion

The influence of quas *on the physical properties of paper.*

The results are presented in Fig. 1.

It appears from the data shown in combination II that just multiple washing in water caused swelling of the structure of paper followed by the decrease of the breaking weight and tear resistance. The breaking weight was much more sensitive to the washing than tear resistance. The disinfecting bath in *quas* without washing with water (combination III) caused a considerable cumulation of *quas* in the paper. The *quas* content in the paper was 13730 ppm which is equal to the concentration of 1.37% of this salt. This would indicate the capability of the compound to concentrate in the paper. The presence of *quas* in the paper induced a distinct decrease in physical properties (breaking weight and tear resistance). These decreases, although ranging in breaking weight about 22% and in tear resistance about 18% were, however, not proportional to the very high content of *quas* in the paper.

Many washings of the paper after the disinfection bath in *quas* solution easily removed this compound from the paper and was followed by an increase in the physical properties of this material. The whole washing cycle of separate sheets in tap and distilled water (combination VI) caused a complete elution of *quas*

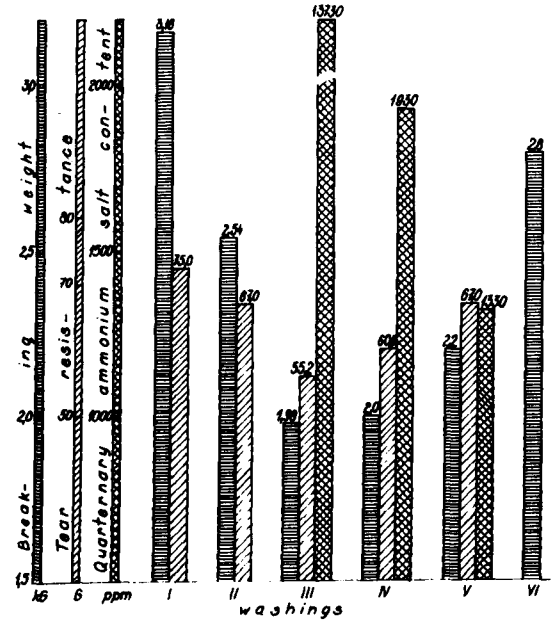

Fig. 1. Correlation between the "quas" content and strength properties of the paper.

from the paper and almost complete recovery of the breaking weight and tear resistance values. This fact would indicate that the *quas*-cellulose complex is of physical, but not of chemical character.

Two properties, breaking weight and tear resistance, were considered in our studies. According to Rosa[9] these are the most sensitive parameters indicating the degree of paper swelling (tear resistance) and strength of cellulose fibres (breaking weight).

The results of our studies on the possibility of *quas* elution from molded or thermal-aged papers indicate that washing after disinfection according to combination VI caused complete removal of *quas* from them. It appears from the above data that neither degradation of cellulose induced by the fungi nor aging affected the absorption of this compound by cellulose. This problem is of great importance for conservation practice, because paper antiquities are almost always deteriorated by aging and very often cellulolytic fungi take part in this process.

The effect of residual quas *on the properties of paper after thermal aging*

The residue of *quas* in treated but unwashed paper induced considerable changes in its properties. The decline in physical properties of paper accelerated markedly during the process of thermal aging.

The aging of treated paper samples has been compared with the control (Table 3, Fig. 2). The extent of degradation depended upon the time of aging. It is interesting that after 6 days of aging the destructing changes caused by the presence of *quas* were still not visible. Remarkable changes were found after 17 days and these increased after 35 days of aging.

Table 3. Changes in pH, degree of whiteness and alpha-cellulose content in paper after disinfecting bath without washing during the process of thermal aging.

Time of aging (days)	pH		Whiteness (%)		Alpha cellulose (%)	
	Control*	*quas* saturated	Control*	*quas* saturated	Control*	*quas* saturated
0	7.31	6.37	95.86	93.89	98.61	–
6	5.36	5.76	73.34	72.05	87.20	90.49
17	5.67	4.50	56.25	34.84	90.52	57.03
35	5.10	4.33	39.22	25.75	67.21	21.97

* – washed 10 min with H_2O dist.

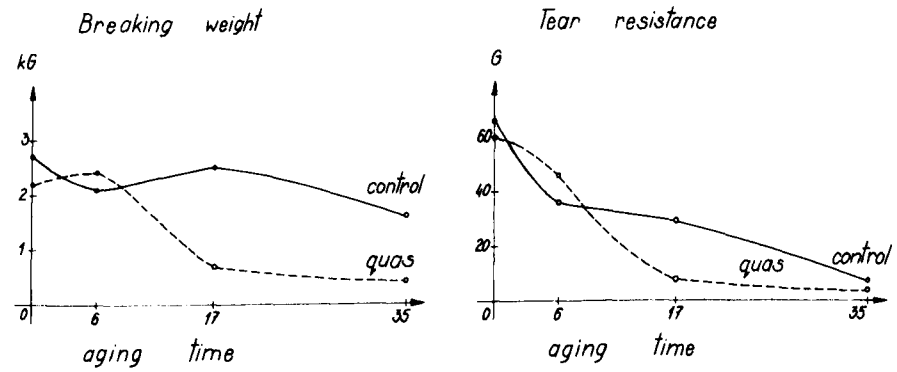

Fig. 2. Changes in the breaking weight and tear resistance in paper after disinfecting bath without washing during the process of thermal aging.

These observations are in accordance with the data of Triolo et al.[7] on the harmful action of *quas* on the properties of paper.

In our studies, washing of paper after disinfection induced a considerable decrease in its *quas* content. After 3 washings with distilled water, the content of this salt was 2450 ppm, or 0.25% *quas* in dry paper (Table 4, combination AI). The content of this salt in unwashed paper as indicated above was about 13700 ppm (Fig. 1). The washings presented in Table 2 (combination AII–AIV) caused further decreases of the *quas* content in the paper but these were much smaller (Table 4). Changes in pH and the degree of whiteness after a series of washings indicate lack of correlation between these properties and the stated small decrease in *quas* content.

In our opinion, a significant decrease in the content of alpha-cellulose under the influence of *quas* was not induced by a degradation of cellulose. It seems however that this is connected with the surface active properties of *quas* that affected the increase of the amount of beta and gamma fractions during the quantitative determination of alpha-cellulose.

The results presented in Fig. 3 indicate that repeated washings decrease the amount of *quas* in paper. As a result, an increase in the physical properties of paper was observed.

More recent studies indicate that 3 successive washings of separate sheets of paper with dist. H_2O at 50°C cause almost complete elution of *quas* (400 ppm).

Table 4. Changes in pH, degree of whiteness and alpha-cellulose content in paper after disinfecting bath, a series of washings and 17 days of aging.

Combinations				
0*	AI	AII	AIII	AIV
pH				
6.33	5.01	5.35	5.57	5.43
Whiteness %				
55.60	53.75	56.48	52.94	53.04
Alpha-cellulose %				
92.21	78.28	75.74	77.03	75.91
Quas* Content ppm*				
0	2450	2350	1850	1700

* – washed during 10 min with H_2O dist. without disinfection.
** – the content of *quas* was determined in non-aged paper.

This small amount of *quas* remaining in the paper cannot act harmfully in it.

Such a low content of *quas* obtained by the application of few washings in warm water is of considerable importance for prolongation of the durability of ancient paper. The prolongation of the soaking time in water induces its swelling and weakening. This, however, should be avoided.

The warm water (50°C) used for washing does not accelerate the destruction of the paper. In such conditions, ancient papers are always washed in the course of conservation. Washing in warm water may remove stains from the paper. Moreover, it is a useful practice from the point of view of conservation technique.

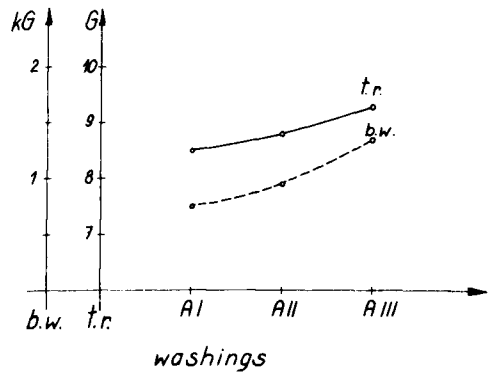

Fig. 3. Changes in the breaking weight and the tear resistance in paper after disinfecting bath, a series of washings and 17 days of thermal aging.

Conclusion

1. The *quas* (*dimethyllaurylbenzyl ammonium bromide*) studied in this work has the ability to cumulate in the paper. The cellulose-*quas* complex is of a physical character. By a series of washings in tap and distilled water *quas* can be removed from the paper (Fig. 1, Table 4).
2. This compound left in the paper causes a decrease of its properties (Fig. 1) and is drastically deepened during the process of thermal aging (Table 3, Fig. 2).
3. The removal of *quas* from the paper through washing restores its strength properties (Fig. 1). This was also present after thermal aging (Fig. 3).
4. After 3 successive washings in distilled water the *quas* remained in the paper in amount of about 1700 ppm. However, this concentration is still not harmful to the paper.
5. Three successive washings with dist. H_2O at 50°C removes almost completely the *quas* from the paper (to about 400 ppm).
6. *Quas* can be used without any objections as a disinfectant for molded non-coloured paper objects such as prints, maps, book sheets. After the disinfection the object should be washed 3 times with dist. H_2O at 50°C.

Summaries

The Effect of Disinfection with Quarternary Ammonium Salt Solution on Paper

Previously it was proposed to use 0.75–1.0% water solution of *dimethyllaurylbenzyl ammonium bromide* (*quas*) as a disinfectant for molded paper antiquities (non-coloured printed sheets). A 15 min warm bath aided by brushing, containing this salt disinfects the object and easily removes dirt and fungal

deposits.[4] After disinfection the object should be thoroughly washed with tap and distilled water. The purpose of this work was to study: 1) the effect of disinfection in *quas* on physical properties of paper as well as on the conditions of the elution of this compound from the paper and 2) the influence of *quas* residue on the properties of paper after thermal aging.

L'effet produit sur le papier par la désinfection avec une dissolution de sel d'ammonium quaternaire
Précédemment on a recommandé l'usage d'une dissolution en eau de 0.75 à 1.0% de *bromure d'ammonium diméthyllaurylbenzol (quas)* comme désinfectant pour les antiquités de papier moulé (papier imprimé sans couleur). Leur immersion pendant 15 minutes dans de l'eau chaude où il y a ce sel avec des coups de brosse les désinfecte et en ôte la crasse et les moisissures. Ce traitement doit être suivi d'un lavage scrupuleux avec de l'eau du robinet et de l'eau distillée. Le but de cette étude est de considérer: 1) les effets qui résultent de la désinfection avec *quas* sur les caractéristiques matérielles du papier. En outre on examine l'élution de ce composé du papier. 2) l'influence des résidus de *quas* sur les caratéristiques du papier après le vieillissement thermique.

Die Auswirkung der Desinfektion von Papier mit einer quartären Ammoniumverbindung (quas)
In einem früheren Artikel wurde vorgeschlagen, als Desinfektionsmittel für handgeschöpftes altes Papier (bedruckte Seiten, keine Farbdrucke) eine 0,75–1%ige wäßrige Lösung von *Dimethyllaurylbenzyl-Ammoniumbromid (quas)* zu verwenden. Ein warmes Bad von etwa 15 min Dauer nach mechanischer Reinigung desinfiziert das Papier und entfernt Schmutz und Pilzreste leicht und nachhaltig. Nach der Desinfektion sollten die Objekte gründlich mit destilliertem Wasser gewaschen werden. Mit der vorliegenden Arbeit sollten untersucht werden: 1. Die Auswirkung einer Desinfektion mit quas auf die physikalischen Eigenschaften von Papier sowie die Bedingungen für die Entfernung dieser Verbindung aus dem Papier. 2. Der Einfluß von quas-Rückständen auf die Eigenschaften von Papier nach thermischer Alterung.

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Prof. dr. hab. Alicja B. Strzelczyk and J. Rożański (M.Sc.)
Laboratory of Paper and Leather Conservation

Institute of Conservation and Restoration of Antiquities
N. Copernicus University
ul. Sienkiewicza 30/32
87–100 Toruń
Poland

Handling, Storage and Preservation of Sound Recordings under Tropical and Subtropical Climatic Conditions[1]

by DIETRICH SCHÜLLER

Introduction

More than 100 years have passed since Thomas A. Edison invented the phonograph. Already in 1899 the Academy of Sciences in Vienna founded the Phonogrammarchiv, the first sound archive of the world. But only during the 1960's and 1970's were audiovisual media including sound carriers widely used. In some cases we find specialized media-archives but the greater part of av-media are held in smaller collections attached to research institutes and libraries. In Third World countries this trend becomes even more important, as in orally transmitted cultures the written document is a poor and insufficient substitute for the highly complex acoustical communication used in speech and even more so in music. While taking over national responsibility for documentation of and research into the plurality of their cultures, an even stronger emphasis on sound recordings and other av-media documentation seems to be inevitable. Sound carriers, however, are subject to deterioration to a much higher degree than conventional print media, especially under tropical and subtropical conditions. Considering the worldwide lack of intimate knowledge about handling, storage and preservation of av-media, and especially sound carriers, it seems to be advantageous first to survey the general requirements for proper handling, storage and preservation and then to take into account the peculiarities caused by tropical and subtropical climatic conditions[2]. For practical reasons this study is restricted to conventional sound carriers only, i.e. the vinyl disc (LP) and magnetic tape. An appendix will deal with the compact disc (CD) and future developments.

Before dealing with the nature of our sound carriers it may be useful to point out the principal difference between print media and audiovisual media. The written word represents a verbalized mental process by a series of representational symbols. There is a certain amount of redundancy and, without any real detriment to communication, letters and words may be omitted. Av-media, on the other hand, represent a physical state (in the case of photographs) or a physical process (in the case of film or sound records). Each detail of this record

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is information and, in contrast to the written word, losses can only be reconstructed with a certain comparatively low degree of probability. The essential value of an av-document, however, lies in the very information it supplies over and above what can be transcribed. It is therefore essential that these details are recorded and preserved with utmost accuracy.

Microgroove Disc and Magnetic Tape

Microgroove records (vinyl records) are discs made from PVC/PVA copolymer, and have been produced since 1948. Today the most common formats are the "single" (45 rpm, 7″ diameter, 3 min/side) and the "LP" (33⅓ rpm, 12″ diameter, 20–25 min/side). The groove in the form of a spiral carries the information which is encoded by lateral and vertical deviations. Only the undamaged groove guarantees the quality of the recording. This calls for cleanliness as well as chemical and mechanical stability. In view of the relative softness of the material the demand for mechanical stability is the greatest problem in handling these discs. The magnetic tape on the other hand consists of two layers: the base and the magnetic coating. Previously, acetate cellulose and sometimes PVC were used for base materials whereas today normally only polyester is used. In open-reel tape the magnetic layer consists of iron oxide, while compact cassettes additionally use chromium dioxide or iron ("metal"), and the respective binders. This oxide layer carries the information in form of a chain of alternating magnetic fields. As with discs, cleanliness, chemical and mechanical stability of the material is necessary to ensure the quality of the recording. In addition, the stability of the stored magnetism is of course a principal necessity.

Before dealing with all the factors relating to handling and storage it seems to be necessary to speak about deterioration by normal use. As stated before, vinyl discs are very sensitive. Extreme care in handling these records and the most accurate maintenance of equipment are necessary to avoid damage. It is essential to choose the right stylus, to carefully control its shape and the tracking force ("needle pressure"), and to avoid damage caused by carelessly placing the needle onto the record. Experience tells that even the best training of the staff cannot guarantee to avoid accidental damages. Therefore the use of the records has to be limited as much as possible, and long-term preservation of the vinyl disc is only guaranteed by systematically copying the records onto tape which then serves for everyday use. The record itself should only be used again for making another working copy, if necessary.

With tapes, the danger of deterioration through normal use is more or less negligible. A precondition, however, is regular maintenance, i.e. cleaning and

demagnetisation of the equipment to avoid loss or damage of the recorded signal.

Enviromental Factors, Recommendations for Handling and Storage

Temperatures above 50°C are a risk for vinyl records as well as for tapes made from PVC (today nearly out of use). The more widely used polyester tapes will tolerate far higher temperatures but it would be unwise to expose tapes to such temperatures as this will result in greatly increased print-through (see below). The general guideline for archives is 20°C ± 3°, whereas longterm storage areas where tapes are rarely used may profit from lower temperatures, say 10°C. Ever present but underestimated risks are heaters, sunshine and lamps which often exhibit quite unnoticed high temperatures, thus endangering records and tapes.

Humidity: Base materials are not really sensitive to humidity. However, humidity constitutes a major risk. Humid climates together with certain temperatures sometimes create ideal conditions for micro-organisms (see below). These then may damage sound carriers. In addition to that, recent studies tell us that the polyurethane binders which hold the oxide onto the base material of the tapes are subjected to a process of hydrolysis. This leads to a loss of oxide particles forming debris or smear that prevents a perfect tape-to-head-contact which again causes deterioration during the recording or replay process. In severe cases this may result in a permanent loss of information. The authors of these new studies recommend even tighter climatic conditions, formerly 50 to 60%, now 40% ± 5% RH, temperature 18°C ± 1.5°.

It is essential to keep in mind that there is a relationship between humidity and temperature; it is therefore necessary to always control both factors simultaneously.

Dust and dirt in their various forms are the most disturbing factors. In the case of discs all particles will be detected as part of the groove. This then leads to the well-known crackles and pops. In the case of tapes dust leads to drop-outs caused by imperfect tape-to-head-contact which especially affects high frequencies. It is therefore essential to look for cleanliness in all sound archives, including having filters in air-conditioning equipment. Floors and furniture should be easy to clean. The sound carriers themselves have to be protected by dust-proof envelopes such as polythene bags. Finger prints, which produce an ideal base for dust, have to be avoided too.

Micro-organisms: Certain climatic conditions stimulate and support the growth of micro-organisms, especially fungus. This is especially the case in hot and humid climatic conditions but can also be found in humid basements in

moderate climatic zones. Mainly, tapes are attacked by fungus; it is the oxide layer which is damaged. Sometimes it will be totally dissolved. Lower humidity and regular airing will be good precautionary measures wherever this danger is suspected.

Further damaging factors for tapes are inadequate *splices*, uneven *winding* and misshapen *spools* which may lead to a permanent deformation of the tape.

Peculiar to tapes is also the print-through-effect which means the unwanted mutual magnetic influence between two adjacent tape-layers. This effect depends on various factors, especially on temperature, and is furthered by external alternating magnetic fields. Therefore the temperatures should be kept low, and alternating magnetic fields (see below) have to be avoided. Print-through, however, is an overrated deterioration, as it is not permanent and can be reduced to a very low level by repeated winding of the tapes.

Magnetic fields, finally, are the natural enemy of magnetic recordings. With increasing magnitude they first start to introduce distortion followed by partial erasure up to the complete destruction of the signal. The limits are different for AC and DC fields: AC fields should not exceed 400 A/m (5 Oe), while DC fields may be tolerated up to 2000 A/m (25 Oe). Microphones, headphones, loudspeakers and VU-meters exhibit far higher magnetic fields. It is therefore necessary to keep recorded tapes well away from these devices. Lightning conductors, too, must be kept away from archival rooms.

The responsible archivist will therefore observe a list of measures to minimize the risks resulting from all these dangers. In the first instance the environmental factors have to be kept within the quoted tolerances and the storing position has to follow the recommendations, that is, upright position for discs and tapes. Above that a bundle of further steps have to be taken: one of them is the *choice of material*. In the narrower sense this is not applicable to discs as they are produced by the industry. Quality control, however, is necessary to guarantee that the supplied specimens are up to the expected quality standards. Concerning tapes, only archival tapes, i.e. standard play tapes (52 µm thickness) with polyester base and low print oxide by well-known manufacturers should be chosen. Original tapes which do not meet these specifications (and this is especially the case with compact cassettes[3]) are not suitable as archival masters in the narrow sense; they therefore have to be copied.Because of the still remaining risks a security plan has to be developed which ideally provides for the deposit of two archival masters in separate places. A compromise may be the deposit of the original material instead of a second archival master. The security plan implies also the production of working copies, especially in the case of discs. At this point it must be stressed that the integrity of av-media in general is highly dependent on the state of the equipment used. Therefore only

high quality equipment and its excellent maintenance guarantee the survival of the media. Beside all these physical dangers, human error constitutes the greatest risk. Therefore, personnel has to be recruited with accuracy and reliability in mind; a permanent process of reinforcing the necessary precautionary measures has to be established. For the sake of completeness it has to be mentioned that the dangers of theft, fire, influx of water, etc. have to be carefully considered.

Let us now turn to those dangers which are peculiar to sound carriers in tropical and subtropical climates. According to the region we will find especially dust, high temperature, temperature fluctuations between day and night, and high humidity.

Dust: Not only in arid zones but also in regions with heavy rainfall a high degree of air pollution by dust has to be considered. This is especially true for urban areas in Third World countries with their comparatively fewer paved roads. Sometimes extremely high concentrations of dust in the air are caused by opening windows in order to ease life in hot rooms.

Temperature and humidity: It need not be explained that in many parts of the world temperature and humidity conditions are not within the tolerance required for the storage of sound recordings. Even in the south of Europe we find temperatures, not only during the day, which drastically exceed the tolerances given above. In addition to that, certain seasons in certain regions see great temperature variations between day and night. If temperature does not exceed 30°C vinyl discs will not suffer. Tape, however, reacts by exhibiting increased print-through effect under high temperatures and cyclic temperature fluctuations. If high temperatures are accompanied by high humidity, tapes are endangered by the above mentioned chemical instability of the oxide binder, resulting in debris or smear caused by abrasive damage to the magnetic layer. Additionally, moist and hot climates are extremely good preconditions for certain kinds of microorganisms. It should be noted that not only sound carriers themselves are subject to fungus growth: more often the various ingredients of the packing materials, especially glue, are an ideal nucleus and nutrient for the spread of fungus.

For all these reasons it is easy to understand that in many cases machine operated air conditioning will be unavoidable to control temperature and humidity. Wherever such equipment exists, dust control may easily be added. It is essential to keep to the necessary climatic parameters throughout 24 hours a day, all the year through. It is furthermore essential to control not only archive areas but all other rooms where discs and tapes are handled. It has to be kept in mind that even short exposures to unfavourable conditions are dangerous, which is true even in the case of regular climatic changes.

It is tragic to think that all these measures have to be taken just in those countries which are not blessed with high budgets for cultural and research purposes. By a bundle of measures, however, it seems possible to keep costs within tolerable limits. The first thing will be rigorous measures towards thermal insulations in archival buildings. The incurred costs will be off-set within a comparatively short time by the resulting lower consumption of energy. On a regional level costs can be avoided through centralization, as it is definitely cheaper to keep one central archive at the necessary technical standard instead of various small decentralized units. And finally – but this is a vision – through international cooperation: security copies could be preserved in countries where costs for long-term preservation are comparatively low.

PROSPECTS FOR FUTURE DEVELOPMENTS

While we have seen that the prevailing sound carriers constitute major problems in terms of their long-term stability, especially under tropical and subtropical conditions, the situation might be relaxed by forthcoming developments. The compact disc (CD) as marketed since 1982/83 is a digital optical sound carrier which in many ways seems to be more stable than conventional media. The lesser vulnerability of the material itself and the ability to eliminate drop-outs and error with the help of an error correcting code reduce the risk to the chemical stability of the disc. In view of the short experience so far, only more or less optimistic guesses can be made of its life expectancy at this point. But this is an issue for all technical committees of international media associations. Until now this type of optical recording was restricted to prefabricated industrial products, but now the development towards self-recording of optical carriers is moving rapidly forward so that it should come within financially feasible limits. We are only at the start of a new development and it is not over-optimistic to say that in all probability during the 1990's there will be a common optical format for print, stills, moving images and sound. This format will exceed all conventional media with respect to invulnerability. A great amount of effort, however, will still be required to reach this goal, especially in the field of standardization to avoid the development of too many incompatible systems and formats.

Summaries

Handling, Storage and Preservation of Sound Recordings under Tropical and Subtropical Climatic Conditions
The material construction of conventional sound recordings (vinyl disc and magnetic tape) is discussed. Recommendations for apt storage are given, regarding temperature, humidity, cleanliness, distance from magnetic fields. Generally sound recordings are more sensitive to these conditions than other library materials. The situation may only be relaxed by the optical disc.

Le traitement, la garde et la conservation des enregistrements sonores dans un climat tropical ou subtropical
On donne ici un traitement de la fabrication des enregistrements sonores conventionnaux (sur disque de vinyle et sur bande magnétique). Des recommendations sont faites pour leur grade en ce qui concerne la température, l'humidité et la netteté adéquates tant que leur éloignement nécessaire des champs magnétiques. Généralement les enregistrements sonores sont plus sensibles à leur environnement que d'autres objets collectionnés dans des bibliotheques. Seul le disque optique peut modifier ces exigences.

Behandlung, Lagerung und Konservierung von Tonträgern unter tropischen und subtropischen klimatischen Bedingungen
In diesem Artikel wird die physische Zusammensetzung von konventionellen Tonträgern (Vinylplatten und Magnetband) näher untersucht, es werden Empfehlungen für eine geeignete Lagerung in Bezug auf Temperatur, Feuchtigkeit, Sauberkeit, Abstand zu Magnetfeldern etc. gegeben. Im allgemeinen sind Tonträger diesen Einflüssen mehr ausgesetzt als andere Büchereimaterialien. Dieses Verhältnis kann sich nur durch optische Platten ändern.

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1. This article was first given as a paper for the 50th IFLA Conference, Nairobi 1984 (Round Table on AV Media/IAML/IASA joint sessions).
2. A complete and thorough discussion of all factors related to handling and preservation of sound recordings cannot be made within this paper. It is recommended, therefore to study the literature indicated in the Bibliography.
3. Although a concise argument cannot be carried out here it must be pointed out that the compact cassette is not up to the technical standards available today. It is not only inadequate as an archival master but should not be employed for original recordings either. It will serve, however, excellently as a medium for distribution at a lower level of technical standard.

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Dr. Dietrich Schüller, Director
Phonogrammarchiv der Österreichischen Akademie der Wissenschaften
Liebiggasse 5
A-1010 Vienna
Austria

Investigation of Fermentative Cleaning Processes in Book Restoration

by YU. P. NYUKSHA & L. A. KARPENKO

Introduction

Most chemicals used in restoration work are distinguished by their low specificity. As a rule, chemical compounds do not provide selective action on certain chemical linkages. This is why it is difficult to influence a single component in a document without affecting all the other components. Scientific restoration makes it necessary to use chemical reactions of high accuracy. Each technological cycle should include strictly definite chemical transformations designed to obtain the effect.

It has been known that a multitude of complicated consecutive chemical reactions take place continuously in biological objects. Their rates and the nature of transformation products are fully provided by the activity of ferments which are biological catalyzers of protein origin. Ferments are proteins with catalytic properties revealed in the ability to specifically activate other components. Substances which are influenced and activated by ferments are referred to as substrates. Substances which inactivate the catalyzer and reduce the reaction rate are called inhibitors. Biological purpose of the ferments consists in directionally increasing the rate of biological reactions and thus in regulating the dynamics of vital processes. Most often, each ferment accelerates only one reaction. As protein-catalyzers, all ferments have an extremely wide range of action.

The high specificity of fermentative reactions limits the effect of each of them to one or several closely affined substances. Many ferments possess absolute specificity, i.e. they can attack only one substrate. This is why ferments are usually called after the substrate on which they act, with addition of the ending "ase". The present nomenclature is based on classification of the ferments depending on the character of the reactions which they catalyze.

The surface of a protein is the mosaic of a multitude of heterogeneous groups belonging to the side-chains of amino acids. The most important advantage of ferments over non-biological catalyzers is their unique specificity. It is determined by a relatively strict arrangement of a multitude of heterogeneous functional groups in a molecule. The portion of a ferment molecule which directly combines with the substrate forms an active complex. This is a complicated structure adapted to close convergence and orientation of the substrate

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and ferment molecule. The substrate molecule is attacked by several catalytic groups at a time. Only some of the interacting pairs participate in the reaction directly, while others serve for oriented attachment of the ferment to the substrate. This ensures a high degree of affinity and a greater probability to form an intermediate complex of substrate with a catalyzer. For disorganized motion occurring in usual reactions, this probability would, in practice, be equal to zero, otherwise an enormous increase in substrate concentration would be necessary. With ferments, these hardly probable reactions turn into highly effective ones. Under usual conditions, ferments provide an acceleration of reactions equal to 10^3 to 10^8–10^{12}. Ferments reduce the activation energy: the reaction may take place at a lower energetic level. Therefore, at a usual temperature, a large number of molecules appear to be involved in a quickly proceeding reaction. The rate of transformations increases considerably and it appears that the ferments cause reactions which do not occur without them. In reality, the ferments accelerate only reactions whose spontaneous occurrence is thermodynamically probable, but whose rate in the absence of a catalyzer is extremely small under usual conditions. The rate can be increased using high temperatures, pressure or strong non-specific agents. Optimum conditions for fermentative reactions are those maintained in living organisms. The first of these consists in that a ferment acts on a quite definite substrate or on a definite type of chemical linkages in its molecule. For relatively small quantities of the substrate the fermentation rate is directly dependent on concentration. Excess substrate leads to inhibition of the reaction most often. Even insignificant changes in the structure or spatial configuration of a substrate molecule may turn the substrate from good to bad, quite unsuitable and, not infrequently, to a ferment inhibitor.

Different chemical substances stimulate or inhibit ferments quite individually. Alcohol, acetone and other organic solvents denature ferments. Biocides can deactivate them. Especially poisonous are the salts of heavy metals, such as silver, mercury and copper. The rate of fermentative reactions increases with rising and decreases with reducing temperature. Low above-zero temperatures inhibit their activity in a number of cases by the Arrhenius rule. Ferments are most often active at temperatures of about 40°C; at temperatures over 45–50°C they are often inactivated. For animal ferments, the temperature optimum varies within 37–40°C, whereas for ferments taken from plants and microorganisms, it is 32 to 55–60°C.

Most ferments are soluble in water. The pH-level has a great influence on the degree of their catalytic action. For the vast majority of ferments, on the whole, the pH-optimum is within 4–8. At pH below 4 and above 9 many ferments lose their activity. Fermentative reactions proceed more successfully in buffer solu-

tions. Because of their protein nature, ferments act as ampholytes: they have a very definite isoelectric point.

The result of fermentative action on the substrate is dependent on the quantitative relationship among the acting components. Therefore, in the course of reaction it is important to know the amount of ferment and substrate and the changes in the latter in the process of catalysis. The amount of products of the transformation which the substrate undergoes related to unit time characterizes the activity of ferment and the processes which it catalizes.

Fermentous Preparations in Restoration

With development of biotechnology, ferments have come out of intracellular biochemistry. They are accumulated in large quantities, identified, cleaned and used with good efficacy and sufficient reliability. Fermentous preparations play an important role in the various branches of industry connected with processing and storing of the animal and vegetable raw materials. Chemical processes based on the catalytic action of ferments have found wide application in agriculture, in food and light industries and in the technological cycles of many other productions.[1] Fermentative reactions are also employed in the practice of restoration. Ferments are used to carry out hydrolysis of protein and fat contaminations as well as of glue and starch paste.

Paper and cloth are the basis of many objects of material culture and, in the first place, of books. Adhesives are a significant part of their materials. Old adhesives, which have changed, resemble contaminations which affect the stabilization and restoration of objects. With respect to paper, this is most often starch paste and glue used for the making and restoration of books and manuscripts. To remove these contaminations from a book or other objects is a very important matter because further restoration work is impossible without this cleaning.

Fresh starch paste swells in the water sufficiently well and reversibly. Parts of a book, including adhesives, can be separated from one another. Adhesives, however, remain in paper. Fermentative catalysis makes it possible to easily free the starch from the fibrous base of paper, cloth and other binding materials using amylolytic fermentous preparations, namely the amylases, and of glue using the proteases. Both destroy the adhesive, but leave intact the cellulose and other components of a book.[2]

Hydrolysis of Starch Paste

The molecular complex of vegetable polysaccharide-starch consists of single

links of glucose. Starch grains are heterogeneous and consist of polysaccharides of two kinds, namely the amylose characterized by 1.4 – α-glucan linkages and the amylopectine characterized by 1.6 -α-glucan linkages. With iodine solutions, the amylose yields a blue reaction and the amylopectin, a red-brown reaction. In starch grains of various plants, the ratio between the amylose and amylopectin is not the same. This affects both the gelation temperature taken into account in the making of the paste and the susceptibility to fermentative hydrolysis. Table 1 gives properties of the starch of four plants.

Table 1: Properties of starch of various origins.

Starch	Amylose content	Gelation temperature, °C
Potato	27	65–75
Maize	21–30	75–85
Wheat	23	80
Rice	17	80

Recent investigations have revealed significant differences in the structure and properties of starch.[3] Thus, electric conductivity of potato amylopectin is 30 times higher than that of maize amylopectin, whereas the concentration of hydrogen ions in a 1% aqueous solution is 150 times as high. Hence, the relatively higher acidity of potato starch. Maize starch contains up to 1% protein and 0.55% bonded fat inhibiting amylase action.

Amylolytic ferments break down the 1.4-α-glucan linkages in chain molecules of amylose and amylopectin. The processes are mainly provided by 1.4-α-D-glucan glucanohydrolase = α- amylase, 1.4-α-D-glucan maltohydrolase = ß-amylase, and 1.4-α-D-glucan glucohydrolase = glucoamylase, correspondingly. Their indices according to the ferment nomenclature[4] are 3.2.1.1, 3.2.1.2 and 3.2.1.3, correspondingly. α-amylases influence the 1.4-α-glucan linkages without a definite order. As a result, dextrins with a molecular mass of 1000 and over are formed. ß-amylases consecutively break down sugar molecules from the ends with formation of maltose.[5]

Processes and conditions of the starch hydrol[illegible]der the action of amylases have been investigated. The rate, fea[illegible]es and laws of deterioration of the starch paste in combination with pap[illegible]been revealed.

Material and Methods

1. Experimental

Samples of paper, 105 × 145 mm in size, were used for the experiments. A 5% paste of wheat flour including edible gelatine and glycerine, 10 % each (of the flour mass), was applied to them. Simultaneously, investigations were carried out using samples in which thin restoration paper was applied on top of adhesive, i.e. the starch was placed between the paper sheets. In addition, a portion of the samples was heated at a temperature of 60°C for 48 h.

Work was done with two amylase preparations. One, with an amylolytic activity of 600 unit/g, and the other with an activity of 3000 unit/g. Preliminary tests have shown that experiments should be carried out with a more effective preparation with an activity of 3000 unit/g although the other preparation, with a lesser activity, is quite suitable for practical work.

The rate of wheat starch hydrolysis was determined under conditions favourable for ferment operation: pH = 6 was maintained with a phospate buffer solution and the temperature of 37°C, using water bath.

Efficacy of the process was investigated for various parameters: concentration of the fermentous preparation, time of attack on sample, substrate concentration (possible amount of samples for simultaneous treatment), paper of different composition, presence of biocides in the paste, and also starch of various origin.

Two factors were taken as criteria for the process efficacy. The first factor was the amount of maltose accumulated in the solution as a result of starch hydrolysis. This also characterized the ferment activity. The photometric method was employed for the determination, namely by the intensity of colouration of the solution using the 3.5 – dinitrosalicylic acid in boiling the reactive solution on a water bath for 5 min. The unit of activity was taken to be such quantity of ferment which liberates 10^{-3}µMol of maltose at a temperature of 37°C and pH = 6 for 1 min. The second factor was the ratio between the amount of starch remaining in the paper and hydrolyzed starch. This was calculated using data obtained in weighing of the samples before and after the treatment. In both cases, dry samples were incubated in the exsiccator for not less than 2 days until a constant mass was obtained. This ratio is referred to as the K coefficient (factor).

$$K = \frac{\text{amount of starch remaining in paper}}{\text{amount of hydrolyzed starch}}$$

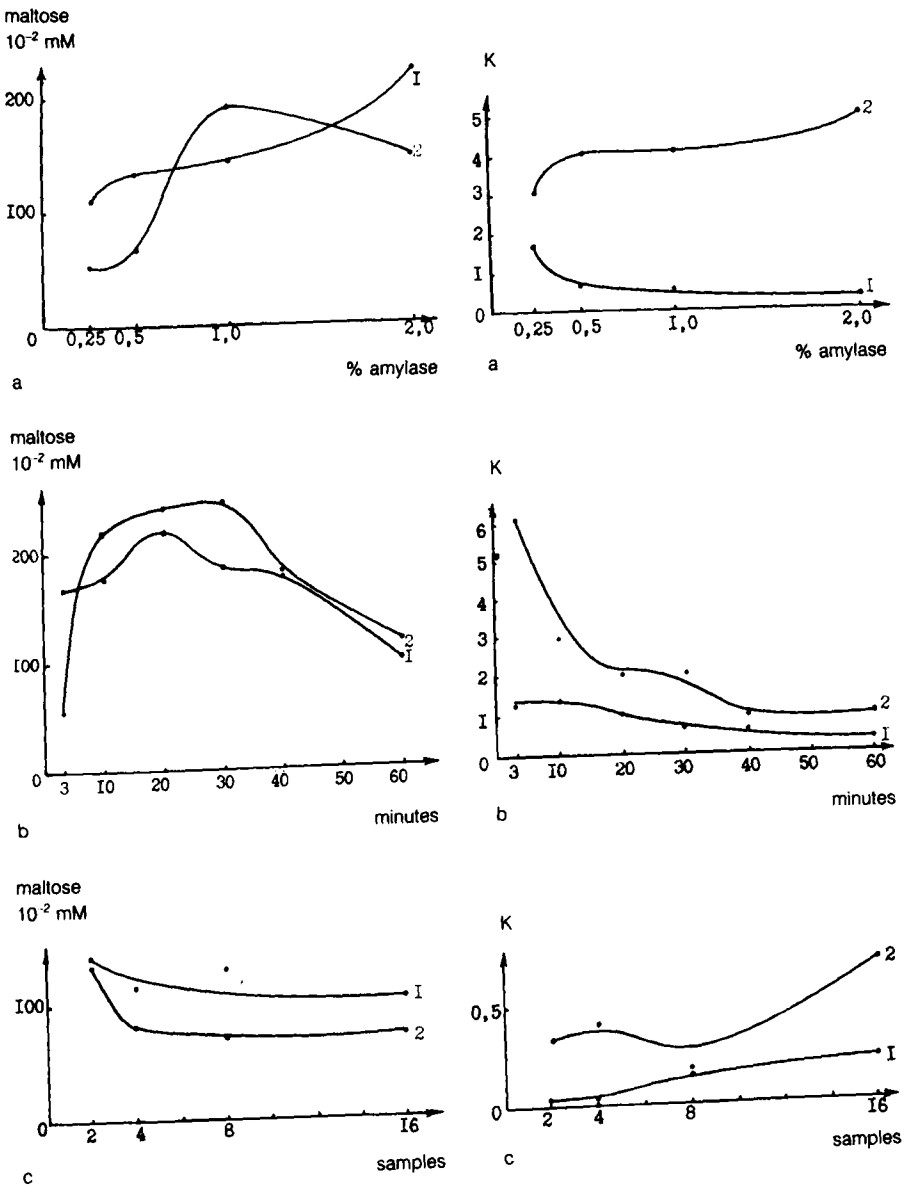


Fig. 1. Formation of maltose depending on a) amylase concentration, b) length of treatment, c) amount of substrate.

Fig. 2. K coefficient depending on a) amylase concentration, b) length of treatment, c) amount of substrate.

The smaller the value of the K coefficient, the more fully is the starch hydrolyzed in the sample. For values of K close to the efficacy of the process of starch hydrolysis is conventionally assumed to be satisfactory. Increasing values of K indicate a corresponding reduction of the process efficacy.

It has been established from the experiments that all of the above factors influence the process and that in each case there are maximum allowable parameters of their own.

2. Amylase concentration

The rate of the process of starch hydrolysis was studied for amylase concentrations from 0.25 to 2%. According to experimental data, accumulation of maltose (Fig. 1a) and the K coefficient (Fig. 2a) vary distinctly for a concentration up to 1%. Further on the processes become stabilized, which indicates that it is no longer necessary to increase the ferment concentration. On account of this, subsequent experiments were performed with amylase preparation solutions having 1% concentration.

3. Time of amylase attack

Dependences obtained between the time of hydrolysis and the characteristics taken for its estimation are given in Fig. 1b and 2b. Appropriate parameters of the processes were determined 3, 10, 20, 30, 40 and 60 min after the beginning of observations. Maximum quantity of maltose was accumulated in the solution after 10–30 min. As the experiment continued, accumulation of maltose decreased. The K coefficient characterized the above-mentioned laws still more distinctly. It also showed a sufficient intensity of starch hydrolysis during the 20–30 min period. Afterwards, the curves ran down monotonically. The processes took place more easily with samples which had no overlaying of the restoration paper on the surface.

4. Substrate concentration

In these experiments, the substrate concentration was expressed in terms of the quantity of paper samples immersed simultaneously in a solution of fermentous preparation. 2, 4, 8 and 16 paper samples were treated one after another in 100 ml of the solution. Fig. 1c and 2c characterized the process evaluated per sample. Maltose accumulation in this case occurred uniformly and did not change much when the amount of the substrate was doubled. Nor did the K coefficient reveal a change proportional to the number of samples in the solution. Thus,

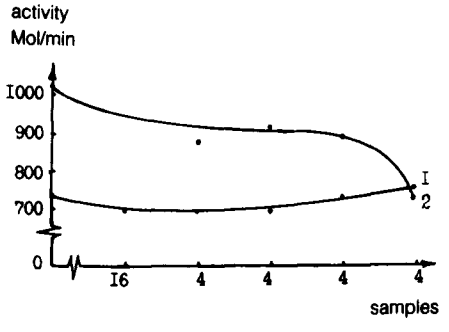


Fig. 3. Residual activity of amylase depending on quantity of samples.

for the amount of paper which was 5% and more with respect to the mass of solution, the amount of starch transformed into maltose from one sample by the amylase remained, in practice, constant. It reached 15%. For any quantity of the samples tested, the K coefficient was not greater than 1. This indicated sufficient efficacy of the process. Therefore, the ratio 15 between the mass percent of the paper treated and the amount of fermentous solution is quite permissible.

5. Exhaustion of amylase solution

Using results of previous investigations we have performed the following series of experiments:

The amylase solution left after treatment of the 16 paper samples was used for 3–4 consecutive treatments, 4 samples each time. Fig. 3 shows data about the residual activity of the amylase solution depending on the number of samples treated. It was found that a gradual loss of the solution took place. After the last summary treatment of 29–32 samples, all of the 100 ml of the fermentous solution was completely expended. In all cases, the process of hydrolysis was sufficiently active until the fermentous solution was nearly completely used up. If paper with recently made patches is to be subjected to the treatment, the above proportion of the paper with respect to the mass of fermentous solution can be increased to 24–28%.

6. Paper composition

The above-described procedure was used to prepare experimental samples of paper different in composition and other properties. Characteristics of some properties of the paper used in the experiments are shown in Table 2.

Table 2: Characteristics of paper properties.

No. Paper	Paper property			
	Bulk density, g/cm³	Basis weight, g/m²	Sizing value, mm	Thickness, μm
1 Newsprint	0.50	51	–	131
2 Writing paper	0.70	72	1.25–1.50	99
3 Printing paper	0.73	70	0.25–0.50	96
4 Coated paper	0.96	220	–	231

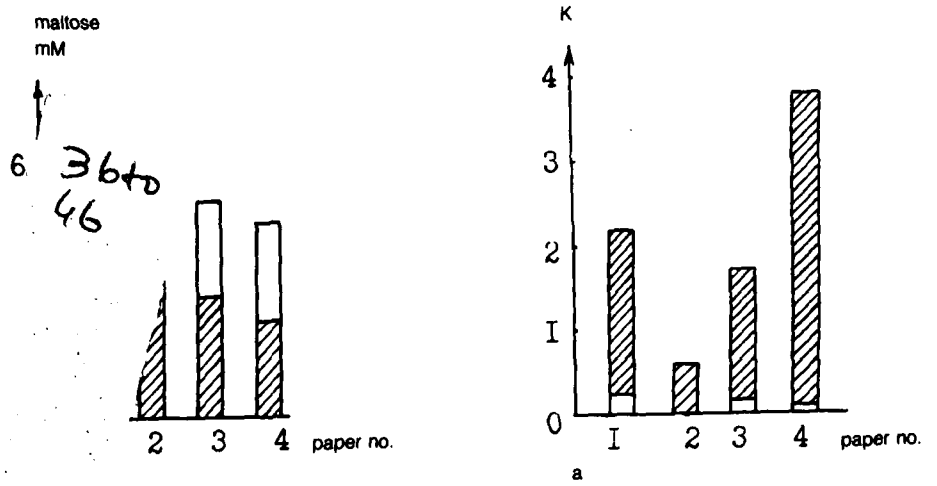
Parameters of the processes of starch hydrolysis appeared to have been different for all four kinds of paper. The amount of maltose formed as a result of hydrolysis of the starch applied to the newsprint paper was the highest, and to the coated paper, the lowest (Fig. 4a). The process efficacy by the K coefficient (Fig. 5a) was maximum during starch hydrolysis with writing paper. The least effective was the process of starch hydrolysis on coated paper.

7. Protection of starch by antifungal substances

The starch paste included antifungal substances used in the restoration to protect it against microbial deterioration. Substances of different chemical nature adopted in a number of restoration laboratories were taken. Their concentrations were determined correspondingly. The antifungal substances used in the experiments are given in Table 3.

Table 3: Antifungal substances introduced in paste.

No.	Antifungal substance	Concentration in paste, %
1	Ca-dimethyl-dithiocarbamate	0.5
2	Alkyl-benzil-dimethyl ammonium chloride	0.5
3	N-cetylpyridinium chloride	0.25
4	Methyl-p-oxybenzoate	0.5
5	Formaldehyde, 37% aqueous solution	0.25
6	Polyhexamethylene guanidine	0.5



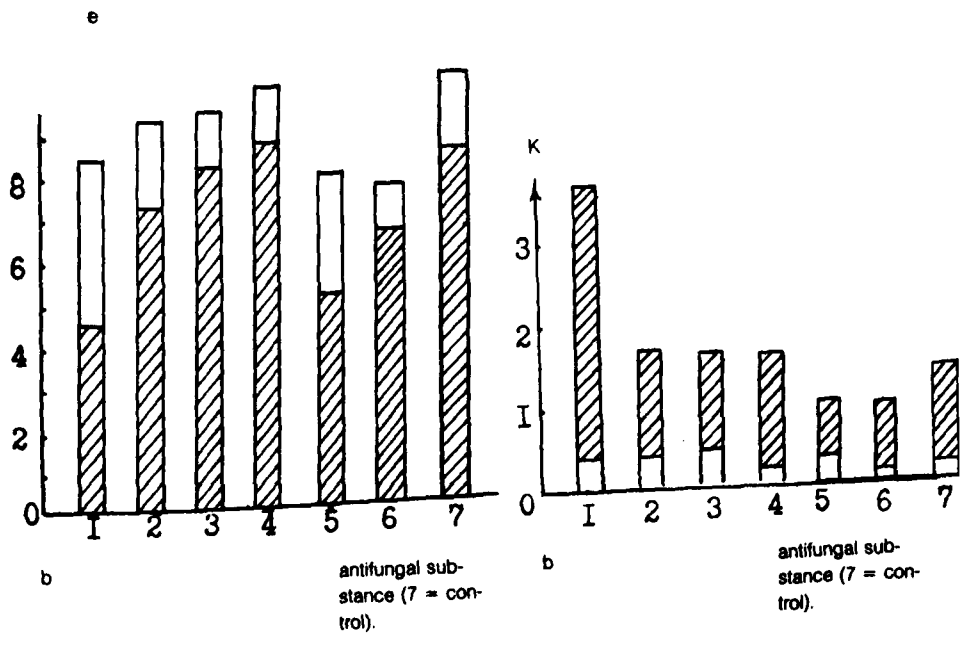


Fig. 4. Formation of maltose for samples a) of different paper, b) with antifungal substance.

Fig. 5. K coefficient for samples a) of different paper, b) with antifungal substance.

Fig. 4b and 5b show quantitatively the process of starch hydrolysis in the presence of antifungal substances. In this case, it was also confirmed that under the restoration paper (shaded part of the columns) the starch paste is hydrolyzed with more difficulty. Each substance influenced starch hydrolysis in its own way. Distinct correlation between accumulation of maltose (Fig. 4b) and the K coefficient (Fig. 5b) was in this case not found, but certain tendencies were nevertheless traced. This, in particular, was expressed in a significant inhibition of starch hydrolysis by Ca-dimethyl-dithiocarbamate if the paste was situated under the restoration paper. On the whole, however, the antifungal substances influenced starch hydrolysis within limits which created no obstacles for their use in the case of subsequent derestoration.

8. Starch of various origin

Hydrolysis of three kinds of starch has been investigated, namely wheat, maize and potato. Their susceptibility to hydrolysis by amylase is shown in Fig. 6. Maximum amount of maltose was formed under the action of amylase on potato starch. Maize starch was more resistant to hydrolysis. Wheat starch was the least susceptible to fermentative hydrolysis. In conclusion, photographs are given of paper with starch adhesive before and after treatment by amylase under optimum conditions. The photographs have been made using a scanning electron microscope (Fig. 7a, b).

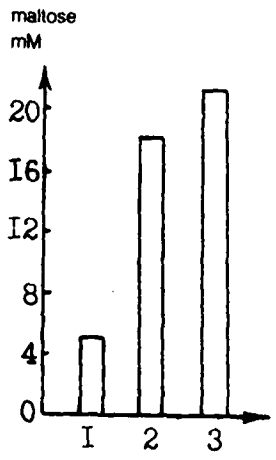


Fig. 6. Maltose formation for samples with starch of various origin: wheat (1), maize (2), potato (3).

Fig. 7. Scanning electron micrographs of paper with starch paste: a) *before treatment* by amylase, b) after treatment by amylase.

Conclusions

1) A quantitative characteristic of fermentative processes used for the restoration of documents is given.
2) Processes of fermentative cleaning of documents of starch adhesives are considered in detail.
3) Optimum conditions for removing starch paste by amylase during the derestoration of documents are as follows:
   (a) amylase concentration, 1%;
   (b) length of treatment, 20–30 min;
   (c) substrate/ferment ratio may reach 15–20 mass percent.
4) Efficacy of the process of starch hydrolysis depends to a greater extent on the thickness of the paper treated than on its bulk density and the mass of 1 m^2. The thinner the paper, the more easily the paste is removed.
5) The six antifungal substances investigated do not significantly influence the processes of starch adhesive hydrolysis.
6) With respect to resistance to fermentative hydrolysis, the kinds of starch tested are arranged as follows, in increasing order: potato, maize and wheat starch.

Summaries

Investigation of Fermentative Cleaning Processes in Book Restoration

A report is made about a series of experiments designed to shed light upon the effectiveness of the enzyme amylase in the hydrolytic reduction of bonding power, for which purpose it is now and then used in the restoration of paper: to loosen strongly glued surfaces for cleaning. Four different types of paper and three degrees of bonding strength were investigated. The application of the enzyme was varied according to concentration and the period allowed to work in. Clear instructions as to the methods of application that yield the best results, are given in the concluding remarks.

Investigation des Procedés Fermentatifs dans la Restauration de Livres

Un rapport est fait au sujet d'une série d'experiences désignées à éclairer l'efficacité de l'enzyme amylase dans la réduction hydrologique du pouvoir de liaison, qui dans ce but est de temps en temps utilisé dans la restauration du papier – pour défaire efficacement les surfaces collées à nettoyer. Quatre types différents de papier et trois degrés de la force de liaison ont étés examinés. L'application de l'enzyme a été variée conformément à la concentration et la periode acceptable à s'insinuer. Des instructions distinctes concernant les méthodes d'application qui produisent les meilleurs réactions sont données dans les observations finales.

Untersuchung von fermentativen Reinigungsprozessen bei der Restaurierung von Büchern

Es wird über eine Versuchsreihe berichtet, die Aufschluß geben sollte über die Wirksamkeit des Enzyms Amylase zum hydrolytischen Abbau von Stärke, wie er bisweilen – zum Ablösen von hartnäckigen Verklebungen, zum Reinigen – in der Papierrestaurierung eingesetzt wird. Es wurden vier Papierarten und drei Arten von Stärke untersucht; die Anwendung des Enzyms war verschieden nach Konzentration und Einwirkungsdauer. In der Schlußbetrachtung werden klare Anweisungen gegeben, unter welchen Anwendungsbedingungen die besten Resultate zu erwarten sind.

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Yu. P. Nyuksha and L. A. Karpenko
Book Conservation and Restoration Department
M. E. Saltykov-Shchedrin State Public Library
18, Sadovaya
191069 Leningrad
USSR

The Awareness of Conservation

Reasons for Reorientation in Library Training[1]

by HELMUT BANSA

The Situation: Misunderstanding and Disinformation

The following deliberations take their start from two remarks given by others, both librarians who are well-known and active in conservation, both remarks regarding conservation and restoration of library collections. The first: "there is a gap between the way a librarian looks at conservation and restoration, and the way of the conservator and technician." [sic] The other: "it is impossible to discuss with conservators. Each of them is saying something different, and in any way the opposite of what his colleague is saying: the librarian will never learn anything useful for himself from these discussions; he will never learn anything he can accept and what can help him to make plans and find out the best conservation policy," [sic].

Both quotations – I trust that the sources (who will remain anonymous), will forgive me if they are not totally word-perfect – reflect the personal experience of those librarians, and in this sense they are very pertinent. One can imagine how these experiences might have occurred. However, one can just as easily say that both statements are utter nonsense. They must be utter nonsense. Were they not, then the situation in the field of conservation and restoration of library materials would always be as unsatisfactory as it is today, or as it is widely considered to be.

What Has Been Done Until Now

Numerous recent publications bear witness to the fact that the situation is unsatisfactory. There is hardly any conference or seminar or other meeting of restorers/conservators not offering lectures on special topics of librarianship, on manuscripts, on history of the book, on the librarian's assessment of restoration, on his demand for the result and the quality of the work done by restorers. There is hardly a librarian's meeting since the 34th Annual Conference of the Graduate Library School in Chicago 1969; there is hardly a journal for librarians in which there are not articles on conservation. The English Journal of Librarianship even devoted its entire April 1985 issue to the theme "Education

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for Conservation". This specific theme was also a topic in the 1981, 1982 and 1983 IFLA General Conferences, namely in the form of numerous "country reports" about training of restorers/conservators and about teaching conservation for librarians. In 1986 the most exclusive club of international librarianship, the Conference of National Librarians, is planning a special meeting, the Vienna Conference on the Preservation of Library Materials.

It is not the intention of this paper simply to offer another contribution on the theme "what must a librarian know about conservation and its techniques", one more to those mentioned above and to those that will be published within the next years. Such essays don't help much. The first was published as early as 1970, as a result of the Annual Conference of the Graduate Library School in Chicago[2], and one would think that by now these articles might have had some effect. Reading all the texts which enumerate what a librarian must know to give competent orders to a conservator or to be really his partner struggling for the same aim, to give competent orders to a technician or an engineer, demanding acceleration, mechanization, industrialization of conservation and restoration treatments; reading how the same subject is iterated again and again and yet seeing that the need for this reiteration is constantly increasing, everybody deliberating on this phenomenon will clearly understand: it is not the transmission of information from which better understanding and judgement can be cultivated. We don't need information: what we need is education, education for a new consciousness of librarianship: very difficult to be found. A new consciousness is always hard to be found. The following comparison may seem to be far-fetched; nevertheless it is applicable. We need an education for a new consciousness which will be as difficult and take as long a time to attain as the re-education of the German people from authoritarian to a democratic political thinking during the first half of our century. To develop this comparison: just as there have been good democrats in the old German empire, so there are already today librarians with the right kind of conservation awareness. And just as there were great philanthropists among the followers of the authoritarian principle at the time when it was the dominating school of political philosophy, and just as certain processes to find decisions moved more easily at this time than today, so some aspects of today's librarianship and today's librarian's consciousness should be carried over to the future. It can be said that reeducation has just found its start, most probably in the U.S.A. The result of these efforts could be seen at the 51st Annual Conference of IFLA, Chicago 1985; there, not only the relevant section was discussing conservation topics, but also some other bodies, e.g. LIBER[3] and the Section on Library Schools and Other Training Aspects. A commercial agency offering conservation service for libraries was present on the exhibition floor and found a wide-

spread interest, just contrarily to the contempt an exhibitor offering permanent/durable paper found at the 49th IFLA Annual Conference 1983 in Munich.

What We Need

The majority of the librarians today, however, are standing at the edge of the gap mentioned above. In their eyes it is more than a gap: it is a chasm.

Combining the two remarks given above, we can design a metaphorical image: the librarian is standing at the edge of a gap and looks across to the other side. Here and there he sees something which excites his attention, which almost seems like a miracle. One can understand, in this image, all the visits to restoration workshops and laboratories which are part of almost all library training in the U.S.A., Canada, England, France, Italy, Scandinavia and Germany. At this occasion enough curious things are shown to the students, and they are expected to judge them as being marvellous. On the other hand the librarian sees people on the other side of the gap who behave oddly, who are constantly quarreling with each other, who are screaming and scolding. He cannot understand them, he cannot make himself understood and he cannot reach them. He does not trust the rope thrown to him by the natives thereabout, and quite rightly. The path down the chasm and up to the other side leads through a river down there: too much effort. The librarian needs a bridge.

Education

The name of this bridge is EDUCATION. This word should be understood in its weightiest context: alteration of consciousness; changing of old habits; giving up one's usual way of thinking with which one feels comfortable; exercising a new way of thinking; a new behaviour that will influence every-day professional life. Things which in the past have instinctively lead to an answer of »yes« will now in the same way lead to the answer »no«, and vice versa. Truly this aim is only attainable over a long period of time. In fact, a great physicist's statement in regard to relativity and quantum-theory is very apt: "new ideas don't succeed by convincing adherents of old ideas; they succeed once the adherents of the old ideas die out."

New information is part of new consciousness. This is not the place to discuss that information which is really librarianship, that which less or more, according to different areas of special librarianship should be part of every librarian's training – although surely, it is not. This is not the place to discuss what a student of librarianship must learn about the history of the book, art

history, about manuscripts, watermarks, fingerprints and construction of quires. A librarian worth this name must know who the Elzeviers and the Didots, Aldus Manutius and Anton Koberger were, what the Flemish and the Reichenau School of book miniatures were. He must know the basics about printing and publishing, about pamphlets and posters, company and governmental reports, about unofficial publications and their worthiness and worthlessness: not all the paper in a library's stocks deserves eternal life. Nor here, neither, shall be emphasised that the librarian learns what deacidification is about, that "acidity" destroys paper, that groundwood is bad for permanence. It is not important that a student of librarianship has once seen foxing stains to be bleached and brittle paper to be laminated. Knowledge of this kind taught one or two times and demonstrated during a visit to a workshop tends to sit unhappily on the surface and all too often does not really exist in minds and hearts that are filled with ideas of "transmission of information" and with thoughts of acquisition policy, cataloging rules, reader advisory service, acceleration of interlending and, at best, regarding the librarian of rare books, with a sense of aesthetics and antiquity. Really, a new librarian is needed. He cannot grow merely out of teaching materials relevant to conservation beside other teaching as it is done in library schools today. The student will not keep in mind these newly taught materials. Specialists for teaching say that the acceptance is, at best, 20%; in other words: information a student shall really catch and keep in mind must be repeated at least five times, each time in another context. The context is all-important. The data which can be assembled under the headline "conservation for librarians" should not just sit on top, like whipped cream on a cake, or be tacked on at the end, like an appendix, to classic subjects of teaching in library schools such as history of the book. They must be raised intensively and often. At first, as a base, in its own systematic curriculum. From there it should infiltrate and penetrate all other subjects taught. The basic course should inject into the librarian's mind the realization that books are not just carriers for information but that they are also a structure of complexly organized materials which, like all highly-ordered materials, tend to a state of disorder.

A Curriculum

Library oriented information about book materials are included in a curriculum that might be organized as follows:

0. Introduction.
0.1. Summary and outline of learning goals: books and other library collections as material objects.

0.2. Selected literature. The bibliographic situation.

1. The material of the book and of other library collections.
1.1. Writing support materials.
1.1.1. Paper.
1.1.1.1. Definitions.
Fibres: cellulose fibres, groundwood, rag. Japanese fibers.
Fillers: clay, calcium carbonate.
Sizing: resin, animal glue, starch, alkylketendimers. Coatings.
Additives and impurities: alum, heavy metals.
1.1.1.2. Cellulose: structure and deterioration (oxidation, hydrolysis, cross-linking).
1.1.1.3. Paper manufacture.
1.1.1.4. History of paper: the road from China across the Islamic world to Europe. Technical development of the paper industry.
1.1.1.5. Types of paper: printing papers, bookbinding papers, technical papers.
1.1.2. Other support materials and information carriers.
1.1.2.1. Historic and exotic writing support materials: papyrus, parchment, palm leaves, bark rind, birch bark.
1.1.2.2. Modern information carriers: film, sound and magnetic tapes, gramophone records, videodiscs.
1.2. Inks and colors.
1.2.1. Printing inks.
1.2.2. Writing inks and colors that are found in manuscripts:
dyestuffs, pigments and binding agents, agents for complex compounds.
1.2.3. Film: silver salts, diazo and vesicular, color film.
1.2.4. Digital information storage.
1.3. Bookbinding materials.
1.3.1. Cover materials.
1.3.1.1. Cover papers: see 1.1.1.5.
1.3.1.2. Covering fabrics: thread count, kind of weaving, finishing. Artificial leather.
1.3.1.3. Leather. Sources: goat, calf, pig, sheep. Tanning and tawing. Graining of goat leather: morocco, oasis-goat, maroquin. Parchment as cover material.
1.3.2. Additional materials.
1.3.2.1. Cloths: gauze, jaconet, mull, cambric.
1.3.2.2. Threads and cords.

1.3.2.3. Adhesives: white glue (PVA), animal glue, paste,methyl-cellulose, hot melts, self-adhesives.
1.4. Protective materials: film sheets and folders of PVC, PE, PEPT.

2. The manufacture of the book.
2.1. Survey: manuscripts, composition, proof, correction, make-up. Electronic typesetting.
2.2. Techniques of production.
2.2.1. Composition techniques: typesetting, cold setting, linotype, monotype, hand setting.
2.2.2. Printing techniques: offset, letter press, roll press, intaglio, ink-jet.
2.2.3. Gutenberg's invention: technology and socio-historic background; development up to the present from the viewpoint of these two aspects.
2.2.4. Techniques of illustration.
2.2.4.1. Chemigraphy: halftone process, rotogravure, photogravure, collotype.
2.2.4.2. Original graphic processes: woodcut and wood-engraving, copperplate engraving, etching, lithography.
2.3. Bookbinding.
2.3.1. Industrial binding: folding machine, machine sewing, production of covers. Production line for books. Dustjackets and packaging.
2.3.2. Job and library binding.
2.3.2.1. Operations in the bindery: collation, pulling, guarding, knocking-down, backing, pressing and lining, etc.
2.3.2.2. Binding types: pamphlet, half and full bindings, etc.
2.3.2.3. Qualitative requirements of library bindings. Pertinent instructions.

3. Copying books.
3.1. Photographic processes: microfilm, microfiche. Scaling, proportions, screen. Halftone, large-size negatives. Color photographs.
3.2. Electrophotography processes: direct copy and reader printer.
3.3. Facsimile.
3.4. Use of copies of books: reading, duplication and reader-printer machines.
3.5. Significance of copies for library management.

4. Handling of books in libraries.
4.1. General procedures: collecting, binding, shelving.
4.2. Ownership marks.
4.3. The binding division: duties, organisation, equipment, budget. Cooperation between the library and the binding trade.

4.4. In-house binderies: duties, organisation, equipment. Aspects of business management and economics.
4.5. Storage and use.
4.5.1. Storage construction and furnishing.
4.5.2. The climate for books. Equipment for checking and control. Problems of full and partial air-conditioning.
4.5.3. Exhibitions.
4.5.4. Limitations on use and education of readers.
4.6. Conduct for catastrophy: emergency measures, helping institutions. Processes for drying books.
4.7. Cleaning and minor repair of books. Leather dressing.
4.8. Book restoration.
4.8.1. In general: basics and ethics of restoration. Selection criteria. Costs.
4.8.2. Work on paper (and parchment. etc.).
4.8.2.1. Chemical treatment: washing, de-acidification processes. Disinfection, bleaching, stain removal, etc.
4.8.2.2. Consolidation: re-sizing, splitting. Laminating with acetyl cellulose, polyethylene, polymethyl-methacrylate, polyamide. Combined re-sizing/deacidification/leaf-casting.
4.8.2.3. Filling-in: applying mends and leaf-casting.
4.8.2.4. Mounting and encapsulation.
4.8.3. Working on bindings: basics and summary of binding history.
4.8.4. The book conservator/restorer: professional image and training.

5. Review and repeat: conservation as a duty of libraries.

The Manner of Teaching

This curriculum is nothing but a draft that needs to be discussed by teachers of library schools together with conservation librarians and together with restorers. Some comments may not be useless for better understanding. Many of the subject headings represent huge areas of knowledge which obviously only can be touched upon. The criteria of selection of what knowledge shall be taught in a library school is always: permanence; long term storage; danger of decay; correct handling; protection from damage. The student of librarianship does not need to learn the difference between mechanical and thermomechanical pulp, between brown and white groundwood. He does not need to know anything about the different types of aluminium silicates and other fillers used by the paper manufacturer. However,he must be as much aware and maybe more than the paper manufacturer of the fundamental difference between calcium carbonate and all other fillers. The difference between these types is fundamental in regard to permanence and aging. The student in a library school of today may learn what was the oldest paper mill in Europe, in America, in his home area; this may be part of his general culture. Necessary for his profession, necessary for library conservation is a knowledge of those technical inventions that led to a worsening and, later on, to an improvement of paper, an area of study first researched by William James Barrow[4]. The whole history of paper can be introduced to the students from the viewpoint of aging behaviour and decay, beginning with the oldest finds in Central Asia, touching the displacements of papyrus from the Orient and of parchment in Europe. The teacher can introduce the names of de la Lande and Wenk, of Schäffer, Robert, Illig and Keller from the viewpoint of permanence - if even he thinks these names to be neccesary. It makes, of course, no sense to attempt to make a printer or a typesetter out of a student of librarianship. Even the practical work in a bindery which is a part of many training programmes for librarians is not very useful. The student, a person of mind, is just as respected as a leniently-treated outsider during this time when he is in the company of craftsmen. He is permitted to bind a pamphlet and to print a title. This will bring him nothing. Instead of this he should learn to understand the construction of a binding, the function of the hollow tube, of knocking down and backing.

Selection

The correct selection from the mass of material will be a major difficulty for the teacher of the course outlined above. One could call it "Book Technology". However, even with the most intense concentration there will be more material left over than most students can remember through note-taking and later reading. It cannot be arbitrarily abridged; a self-contained entity must remain. The lectures should not be made up of series of details lined up together: they need connecting transitions; there must be an intellectual bond. Care should also be taken that the students hear the material which they need to remember *at least* five times, each time in another context. They get the information two or three times in the course outlined. Optimal atmospheric conditions, e.g. are discussed in 1.1.1.2. and 4.5.2; deacidification and alkaline paper are discussed in 1.1.1.1., 1.1.1.4. and again in 4.8.2.1. Three or two times more are resting: they must be executed in other courses and in a total different context.

Penetration into Librarianship

This last point: the body of knowledge necessary for conservation should not only come up in special courses, but also at other times, so that it will penetrate the entire library training: this is extremely important. The information concerning conservation must penetrate the librarian's training in order that later his daily work is based on informed decision. A librarian should not just talk about conservation, he should practice conservation. He should not demand it of others but carry it out himself. Conservation is not only a matter of large, unique projects. As much or even more, it is a matter of small continuous steps. Large projects run the risk of large failures; however, the goal is always reached with small steps. An enormous amount can be done for conservation during the building of libraries: consequently, conservation information should be offered in the course "Library Building" of the library school, repeating the material from the Book Technology Course as discussed above.

People who know the curricula of library schools might say: "that is a lot of material!" They are right. Not every librarian needs to know conservation inside-out; for collections of text-books, public libraries, everywhere the books antiquate faster than they suffer decay, conservation is not an issue. However, one can just as well say that the essential selection of the material outlined above is not enough for the librarian who may later shoulder the responsibility for conservation in a special collection containing actual or potential rare-book-materials or, more correct, books that must survive actual use, e.g. in a National Library. It might be worth thinking about offering students extra optional courses, for example, seminars allowing them to work independently. Not, however, with a bone folder or scalpel or laminating-machine. Only to amplify theoretical work, for instance in preparing a report on the theme of "Technical Possibilities for Consolidating Brittle Paper". Seminar participants can prepare such reports using the technical literature available on conservation and restoration. Possible report subject could include "The Deacidification of Paper", "Historic Bindings", "Inks: Permanence and Possible Damage", etc.

These remarks may be enough to outline the way how a "New Librarian" could be educated. A note on the time necessary for this: The lecture on "Book Technology" should fill ca. 35 class-hours; the optional seminar for specialists about 12 sessions. Again, the U.S.A. is the place where courses like these have been offered by some library schools for many years; the result can now be seen, as mentioned above.

The Teacher for Conservation

One more problem remains: who should teach the "Book Technology" course? Nowhere in the world is there organized training offering the necessary combination and selection of information. Everyone who has received some sort of organized training, which includes more or less the above-described material – the chemist, the paper manufacturer, bookbinder, restorer – each of them must forget more of the subject he has learnt during his professional studies than he can make use of for the course he is teaching at the library school. The second major problem for the book technology course, after making the right selection, is to come up with the right presentation. It must be library-oriented in a very practical way. A non-librarian who does not deal with the daily practice and workload of a library specialist will have a hard time of it. There is little more than that the librarians themselves read up on chemistry and technology in order to be able to teach the subjects themselves. Only few outside the U.S.A. have done this to date. One or another library school may teach knowledge as it is pertaining to conservation; maybe at one or the other place there is offered a whole course on book technology as outlined above. The full penetration of the whole two- or three-year's-course for librarians with knowledge and consciousness as demanded has by far not been realized in any library school. The simple reason: there are no teachers. The common teacher for librarianship, as well as the common librarian, is not familiar with the materialistic stuff of a book and with its technology. He does not like these topics. They are somewhat strange, somewhat from the other side of the gap. This is the main and the essential reason for the unsatisfactory situation in the field of library conservation.

The Restorer

The librarian is one of the people who has to learn, but he is not the only one. Keeping in mind the metaphorical picture used in the beginning, one can say: the natives on the other side of the chasm have to learn, too. They must give up their quarrelling, or rather they must learn to quarrel in a civilized fashion! They must learn to speak in a way that one can understand them. It seems paradoxical, but it could be that education for them is easier to be obtained than education for librarians. I have chosen the metaphorical image of natives for those people on the other side of the gap yawning under the feet of the librarian looking out for conservation: they are noble savages, like Chingachgook and Queequeg. This image can also be used for reality: there is not yet, in fact, a profession of conservator/restorer. There are no solid traditions, as in li-

brarianship, no traditional plan of learning. For restorers all this is only in the process of beginning, and it is easier to build a new house according to special requirements than rebuilding an old house. However, to report on all the attempts to set up an organized training for conservators – already successful in some places – to report about the curricula of such schools and academies, about the proportion of practical and theoretical study, about ability and knowledge: technical, historical, and library knowledge – that is the stuff of another article. This must be written as pointed and as unconcerned of collision that it might find as is written the article above. For there are quite a lot of articles of this kind, all expatiating on the great importance of conservation and the conservator, but avoiding the real need of his daily work.

Summaries

The Awareness of Conservation
Reasons for Reorientation in Library Conservation

In order to overcome the largely unsatisfactory situation in the area of library conservation and restoration, especially to overcome the comprehension difficulties between the librarian, who is responsible for planning for conservation and restoration, and the technician, who carries out the necessary procedures, it is emphasized that not so much the learning of a special science is as important as the infiltration of the entire library training with a special awareness of conservation and restoration. A starting point for this infiltration should be the subject "Book Technology" for which a curriculum is proposed.

La prise de Conscience de la Conservation
Les Raisons de la Réorientation dans la Formation des fonctions d'une Bibliothèque

Afin de surmonter la situation peu satisfaisante dans le domaine de la conservation et restauration de bibliothèques, particulièrement les difficultés de compréhension entre le bibliothécaire qui est le responsable de l'organisation de conservation et restauration, et le technicien qui effectur les procédures nécessaires, on souligne que l'étude d'une science particulière n'est pas aussi importante que la mise en place générale de toute la formation de la bibliothèque avec une prise de conscience spéciale pour la conservation et la restauration. Le point de départ de cette mise en place devrait être le sujet "Technologie du Livre", pour lequel est suggéré un programme.

Konservierung, bewußtsein der Erhaltung
Die Gründe für eine Neuorientierung in der Bibliothekarsausbildung

Es wird engagiert die Meinung vertreten, daß es zur Überwindung der allgemein als unbefriedigend empfundenen Situation auf dem Gebiet der bibliothekarischen Konservierung und Restaurierung, speziell zur Überwindung der Verständigungsschwierigkeiten zwischen dem Bibliothekar, der Konservierung und Restaurierung verantwortet, und dem Techniker, der sie durchführt, nicht so sehr auf das Lehren eines entsprechenden Wissensstoffes ankomme, als vielmehr auf die Durchdringung der ganzen Bibliothekarsausbildung mit konservatorischem Wissen und konservatorischem Bewußtsein. Auszugehen hat diese Durchdringung von einem Lehrfach "Buchtechnik", wofür ein Lehrplan vorgestellt wird.

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1. This text is (slightly changed) the English version of a paper given August 20, 1985 at an *Open Meeting of the IFLA Section on Library Schools and other Training Aspects*. It reflects the situation in Europe, in correct restriction, the situation in Germany. The response of Ann Russel (North East Document Conservation Center, Andover, Mass.) emphasized that, in addition to education for conservation during the ordinary courses for students of librarianship, there must be seminars and advanced training for librarians just in office and specially engaged in the field. During the quite lively discussion that followed it became very clear that the situation regarding the theme the paper is dedicated to is totally different in different parts of the world. Remarks could be heard as – to point out the most evident contrast – "what the paper is asking for is just existing for many years" and "it will be impossible to call the interest of students who are motivated to study librarianship to the topics that are summed up in the paper as basic knowledge for conservation". The decision to publish the paper was supported by the idea to *provoke further discussions*. 1986 RESTAURATOR will go on in this way by publishing another article on the theme referring to relevant experiences in the U.S.A.
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3. Ligue des Bibliothèques Europeennes de Recherche.
4. E.g.: *Physical and Chemical Properties of Book Papers 1507–1949*.Permanence/Durability of the Book 7 (1974): 1–48.

Dr. Helmut Bansa
Institute for Restoration of Books and Manuscripts
Bavarian State Library
P.O.Box 150
D–8000 Munich 34
FRG

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Manuscripts should be original typescripts or superior photocopies (not carbon copies), in double spacing and on one side only of the paper. They must be carefully revised, as alterations in print are expensive. The paper used must be non-absorbent. Author's name should be accompanied by title, position, and working place or institution.

All graphs, drawings, or photographs are to be referred to as figures (abbr: Fig.) and should be numbered in sequence with Arabic numerals. Each figure should be identified with a figure number on the back. Any lines, numbers, or lettering that are to appear in the illustrations should be large enough for the necessary reduction. Line drawings should be drawn with black India ink on white paper and should be about twice the size of the finished blocks. Graphs can be plotted on plain white or blue squared paper; grid lines that are to show should be inked in black. In general, photographs should be about 1½ times the size of the final block and must be submitted as mounted glossy enlargements showing good detail and adequate, but not excessive, contrast. Authors should indicate in the manuscripts the approximate position of text figures.

Italics only are used for emphasis, especially for distinguishing titles of books and papers. Italics are marked in the manuscript by underscoring.

References within the text should be indicated by numbers corresponding to those in the list of references. The list should be placed at the end of the paper and should contain no reading matter. For example:

1. Barrow, William J.: *Restoration methods*. American Archivist 6 (1943): 151–54.
2. Hunter, D.: *Paper Making*. New York 1947.

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