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Paper Permanence: A Step in Addition to Alkalization

by ~~JOHN C. WILLIAMS~~

Research carried out in the last fifty years has established that paper at a low pH embrittles and loses folding endurance rapidly, while paper which is impregnated with calcium or magnesium carbonate to have an alkaline reserve will last for many years.

What are the Dangerous pH Values for Paper?

Jarrell, Hankins, and Veitch[1] acidified cotton flax waterleaf sheets with sulfuric acid, hydrochloric acid or alum, then aged the sheets for 72 hours at 100°C. The % loss in folding endurance is shown plotted in Figure 1 from Williams[2]. Barrow[3] aged refined wood fibre papers of various pH values similarly. His

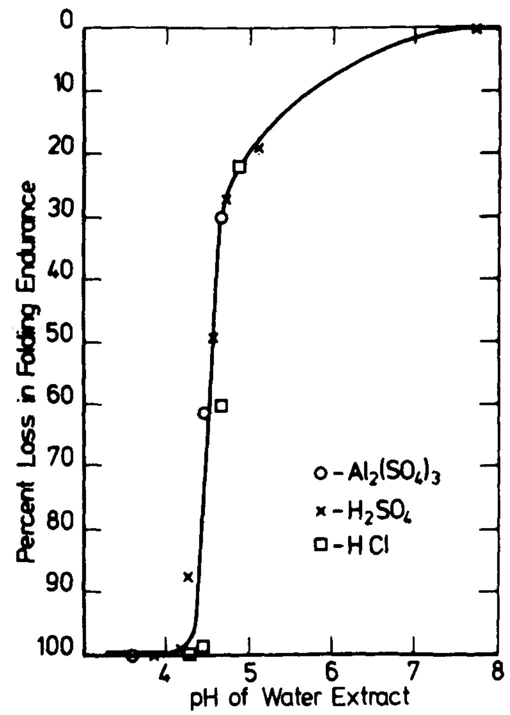

Fig. 1: Waterleaf sheet aged 3 days at 100°C (Jarrell, Hankins & Veitch)
Fig. 1: Vieillissement d'un papier broullard pendant 3 jours à 100°C (Jarrell, Hankins & Veitch)
Abb.1: Blatt der Hydrophyllaceae, 3 Tage lang bei 100°C gealtert (Jarrell, Hankins & Veitch)

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data is plotted in Figure 2. Jarrell *et al* based % folding endurance loss on a neutral sheet given 72 hours oven aging. Barrow based % loss on the original folding endurance of the paper. In spite of this difference, the two curves are remarkably similar. The pierced points on Barrow's curve are from paper not heated, but kept 24 years at room conditions. The fact that they fall on the curve lends weight to the commonly used factor that 72 hours at 100°C is equivalent to 25 years aging.

The steep slopes of the two curves below 5.5 show that the conservator really does not need to measure pH very closely to know when paper is too acid to last.

Paper becomes acid in several ways: first, by being sized with rosin and alum on the paper machine, which leaves it at low pH, second, by contact with acid atmospheres and third, by oxidation. We are all aware of the sulfur dioxide in modern polluted air, and of the oxides of nitrogen produced by automobiles. Recently Dr. Ferdinand Schulze[4] pointed out that libraries often contain more nitrogen oxides inside than are present in the air outside. His method of exposing nylon skeins showed this to be true at the Library of Congress. Our first thought is that this is due to the many pyroxylin coated books in the collection. Oxides of nitrogen are directly acid. They also oxidize the absorbed sulfur dioxide in paper to sulfuric acid.

The direct oxidation of paper depends on the presence of easily oxidizable materials such as lignin and oxidation catalysts. High humidity accelerates oxidation. Easily oxidizable materials generate peroxides, which in the presence of catalysts produce free radicals which directly reduce the molecular weight of polymers, leaving easily oxidizable end groups.

A reasonable value can be selected for the rate at which acid is generated in paper and a prediction made as to how long an alkaline reserve will last.

Kelly[5] noted that:

"The increase in acidity over a 72-hour period of accelerated aging at 100°C in a dry oven was monitored by Rasch & Schribner of the Bureau of Standards in 1933. From their data we have calculated the increase in acidity amounted to about 3.6 milliequivalents per kilogram per day (meq/kg/day) for all-rag papers and 4.0 meq/kg/day for part-rag papers."

Taking the 4 meq/kg per day figure, this would be 12 meq/kg for the 72 hours in the oven which is equivalent to 25 years at room conditions. This is roughly 1/2 meq/kg acid pickup per year.

Since 0.05 grams of calcium carbonate is one milliequivalent at the rate of 1/2 meq/kg of acid per year, the calcium carbonate in alkaline paper would be used up as follows: 4% - 1600 years; 3% - 1200 years; 2% - 800 years; and 1% - 400 years.

How Long Would it Take for Neutral Paper to Drop to pH 4.5?

In 15 years there would be 7.5 meq/kg acid generated in the paper. Taking a standard sample of 2.5 grams of paper and slurrying this in 250 ml of water.

$$\frac{2.5 \times 7.5}{1000} = 0.01875 \text{ meq in 250 ml of water}$$

To express this as milliequivalents per liter, multiply by 4, and to write as equivalents, divide by 1000.

$$C_{H}+ = \frac{0.0187 \times 4}{1000} = 0.000075 \text{ equivalents per liter}$$

If the acid were only 50% ionized this would be 0.000037 equivalents of hydrogen ion per liter. If the acid were only 25% ionized this would be 0.000018 equivalents per liter. Using the Sørensen relation

$$pH = -\log C_{H}+$$

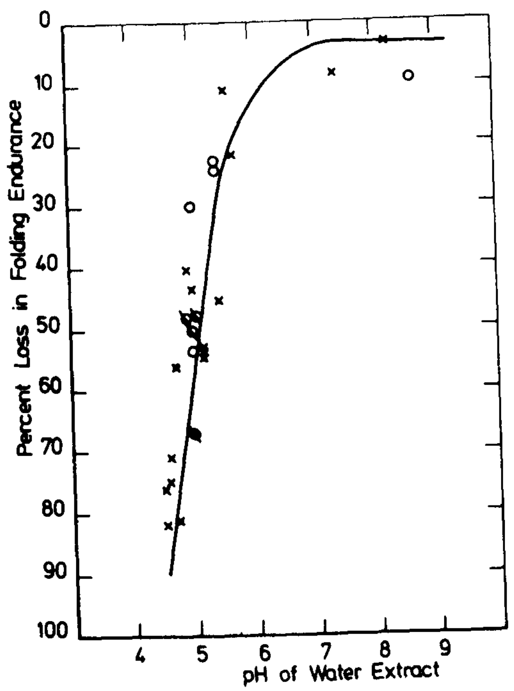

Fig. 2: Paper aged 3 days at 100°C (Barrow).
Fig. 2: Vieillissement d'un papier pendant 3 jours à 100°C (Barrow)
Abb.2: Papier, 3 Tage lang bei 100°C gealtert (Barrow)

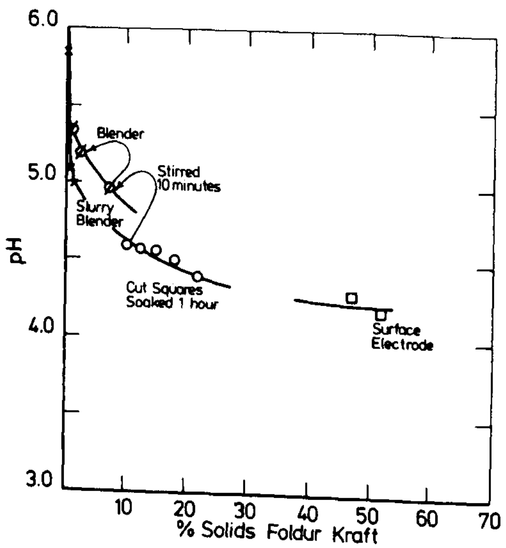

Fig. 3: pH values at various percentage solids of Champion Foldur Kraft paper.

Fig. 3: Valeurs du pH pour diverses valeurs de la matière sèche de papier Champion Foldur Kraft.

Abb. 3: pH-Werte bei verschiedensen Anteilen von festen Bestandteilen in Champion Foldur Kraft Papier.

These values can be put into pH units

100% ionized - pH 4.1
50% ionized - pH 4.4
25% ionized - pH 4.7

These are all dangerously low pH values, as illustrated in Figures 1 & 2.

These calculations show the great benefit of giving paper an alkaline reserve. They also indicate that neutral paper will easily go acid and not last very long. Washing acid paper removes acids and degradation products and may raise the pH close to 7. However, there is no guarantee that it will remain at that pH. Conservators who are satisfied with merely washing paper are too easily satisfied.

A Digression on the Subject of Measuring Paper pH

The actual pH of paper is not ordinarily measured. Paper contains 4 to 6 percent moisture which changes in response to ambient humidity. The concentration of hydrogen ions in this water of humidity governs the rate at which the cellulose molecule hydrolyzes. However, the water content of the paper is too low for this concentration to be measured, using the pH meter. Instead, an aqueous extract of the paper is made in a standard manner and the pH of the extract is measured. Barrow[3] found a better correlation between pH and loss of folding endurance from the cold extraction rather than from hot extraction.

Standard Extracts

TAPPI T509 os 77 directs that 1 ± 0.01 grams of paper be cut into 5-10 mm squares, macerated with $5cm^3$ of distilled water and the volume of water brought to $70cm^3$. The solids in this extract are 1.4%.

Jarrell, Hankins, and Veitch[1] ground acid paper samples in a Wiley mill. To determine hydrogen ion concentration, 2½ grams of the ground sample was tranferred to a 250cc pyrex glass Erlenmeyer flask and 125cc of boiling distilled water was added. The flask was stoppered and cooled. The solution was then decanted off and the pH determined using the Quinhydrone electrode. Since this work was with waterleaf sheets, hot and cold extraction would be equivalent. The solids in this method are 1%.

Kelly[6] of the Library of Congress Research and Testing Laboratory opens 2.5 grams of paper in 200 ml of distilled water in the blender 45 seconds, then rinses the blender with 50 ml of distilled water. The pH reading is taken while stirring the sample with a magnetic bar. Total acidity is determined at this time by titrating the acid slurry directly with 0.1 normal sodium hydroxide. For alkaline slurries, 0.1 normal hydrochloric acid is added to bring the pH below 3 and the sample is boiled while stirring for one minute. It is cooled to room temperature and brought to pH 7 with 0.1 normal sodium hydroxide. Results are expressed as meq/kg, the pH record showing whether this is acid or alkaline.

$$\frac{1000\ (\text{ml acid} \times \text{normality} - \text{ml alkali} \times \text{normality})}{2.5} = \text{meq/kg}$$

Since one milliequivalent of calcium carbonate is 0.05 grams,

$$\text{meq/kg} \times \frac{0.05}{10}$$

gives the percent of alkalinity as calcium carbonate. The method does not distinguish between desirable calcium carbonate and the much less desirable sodium carbonate. However, this information is usually available from the history of the sample.

The solids in this method for pH are 1%.

How do Percentage Solids in the Standard Extract Affect pH?

In Figure 3 pH values have been taken at various percentage solids of Champion Foldur Kraft paper. The first set of points between 2.5 and 0% solids were from the fibre slurry produced by the blender. The flat glass electrode was immersed in the slurry for these readings. The readings using TAPPI 1.4% slurry and the 1% slurry would vary by less than a 0.1 of a pH unit.

The second set of points was taken from cut strips of paper soaked for one hour as directed in TAPPI T509. These slurries, being at higher concentration than the blender samples, do show lower pH values. The electrode was immersed.

The third set of readings was made on weighed wet paper using the electrode as a surface electrode. Contact was poor at these solids and erratic readings were obtained.

The ratio of paper to water in the surface use of the flat glass electrode, i.e. the % solids, is not under good control and this is a defect of the method. The flat glass electrode will generally be reading at a higher solids than in the slurry method and so will give lower pH values. The center and the surface of the paper may well be at different acidities, so that the surface reading may take some time to stop drifting. However, the flat glass electrode will register pH values in the danger zone and so can give the required information in a test.

Trace Metal Catalysts in Paper

Oxidation of easily attacked materials in paper, rosin, and lignin, produces peroxides. According to Isbell, Parks, and Naves[7], traces of iron catalyst and peroxides generate free radicals. These can break carbon to carbon bonds. Effects of trace metal catalysts in paper were also discussed by Williams, Fowler, Lyon and Merrill[8].

The presence of trace metals in paper can be rapidly determined using atomic absorption spectroscopy or by energy dispersive x-ray fluorescence. The values obtained do not tell whether the metal is catalytically active. This requires some type of chemical test.

Langwell[9] made the interesting suggestion that sulfur dioxide from polluted atmospheres is loosely held as an addition product on aldehyde groups in the cellulose molecule. In the presence of metal catalysts these are oxidized and hydrated to sulfuric acid – with a great drop in pH. He noted that this oxidation process required the presence of moisture. Langwell[10] proposed a test in which one gram of humidified paper was exposed to approximately 0.5% sulfur dioxide for seven days and then analyzed for sulfate radical. Traces of iron, copper, and manganese compounds increased sulfate content, while addition of a complexing agent such as EDTA reduced it.

Langwell[11] also found that the catalysts could be inactivated by treating the paper with potassium ferrocyanide or disodium pyrophosphate solutions.

Experimental

In the following section, slurried paper has been treated with dilute hydrogen peroxide with and without oxidation catalysts present. The acid generated has been followed by taking the pH of the slurry and by measuring the increase in total acid. The method, which is somewhat related to the P.I.R.A. test in leather, is considered suitable to show the presence of active oxidation catalysts and to follow the inactivation of such a catalyst.

The effect of potassium iodide, which decomposes peroxides and inactivates free radicals is shown.

The effect of lignin and oxidation catalysts on lowering the pH of paper was studied in the following experiments:

1. The effect of lignin (newsprint) on oxidation. In the following experiment, 2.5 gram samples of four papers were opened in 250 ml of water in the blender, the pH of the slurry was taken and total acidity was measured. The procedure left the samples at pH 7. Ten grams of 5% hydrogen peroxide were then added and the samples were heated, with stirring, to 95-100°C for 15 minutes. They were then cooled and the pH and total acidity again taken.

	Initial Sample		H_2O_2	Oxidized Sample	
	pH	meq/kg		pH	meq/kg
Newsprint	4.7	52	at pH 7	3.9	221
Foldur Kraft	4.8	22	at pH 7	4.9	28
Government Printing Office JCPA-60	6.3	6	at pH 7	4.6	46
Allied Superior	6.2	10	at pH 7	5.0	28

Conclusions: Newsprint was easily oxidized and brought to the pH of rapid hydrolysis. Foldur Kraft and JCPA-60 are also in the danger zone but with much less acid produced.

2. In this experiment, the same techniques were used with one paper, Foldur Kraft. Oxidation catalysts were added and then in a second sample their effect was curbed by addition of an iodide (KI).

Initial Sample pH	meq/kg	catalyst ppm	anti-catalyst ppm	H_2O_2	Oxidized Sample pH	meq/kg
4.8	22	–	0	at pH 7	4.9	28
4.8	24	102 copper sulfate	0	at pH 7	3.4	397
4.8	27	102 copper sulfate	305 I^-	at pH 7	4.1	66
		112 copper gluconate	0	at pH 7	3.2	540
4.6	28	112 ferric sulfate	0	at pH 7	3.9	157
4.7	30	112 ferric sulfate	305 I^-	at pH 7	4.0	104

Conclusions: The copper sulfate and gluconate greatly increased production of acid groups. The iodide repressed this. However, pH of all oxidized samples is in the danger zone. The iron catalyzed oxidation but to a lesser extent than copper. The ferric sulfate was not well dissolved and three days later had produced a heavy floc. This would account for its poor performance.

3. In this experiment the same techniques were carried out using Foldur Kraft treated with magnesium carbonate. The hydrogen peroxide in this case was added to the alkaline paper rather than neutral.

Initial Sample pH	meq/kg	catalyst ppm	H_2O_2	Oxidized Sample pH	meq/kg	Acid Generated meq/kg
9.4	246	none	added to alkaline paper slurry	9	173	73
	246	102 copper sulfate		5.7	76	322
	246	112 ferric sulfate		9.3	117	129

Conclusions: The catalytic effect of the copper is in evidence and has operated on the alkaline side in the presence of magnesium. The iron has been less active but still has operated on the alkaline side and in the presence of magnesium.

Observation: These results are qualitative but point the way to the study of catalysts and anti-catalysts in paper.

CONCLUSIONS

Paper with an alkaline reserve and free of oxidation catalysts, properly stored, is an excellent long lasting record keeping material. The early papers made from rags worked up in lime, in wooden equipment, have lasted extremely well, even in modern polluted atmospheres.

Papermakers are slowly changing back to alkaline furnishes for the many advantages that they offer. Such furnish leaves the desirable alkaline reserve in the paper. It also does not dissolve iron piping to put trace metal catalyst in the paper. Papermakers are also abandoning the brass forming screen and are going to plastic. This again means less catalyst in the paper. Hopefully, 1000 year paper will again become commonplace. However, conservators, librarians, and archivists must continue to demand such paper and run quality control to see that they get it.

SUMMARIES

Paper embrittles rapidly when its pH is below 4.7. Acid free papers with pH values from 6 to 7 last longer. However, the pH of acid free, unbuffered papers drops to the danger zone as the result of exposure of the paper to polluted atmospheres and from acid generated internally by oxidation. Trace metal compounds which act as oxidation catalysts speed the oxidation of sulfur dioxide to sulfur trioxide, and accelerate the drop in pH due to direct oxidation of the cellulose.

The acids generated can be neutralized by an alkaline reserve in the paper. This reserve will obviously last longer if the trace metal catalysts are removed or inactivated. The demonstration that oxidation catalysts are present and that a given procedure will inactivate them is discussed.

Durabilité du papier. Un nouveau pas important joint à l'alcalinisation

Le papier s'effrite rapidement lorsque son pH est inférieur à 4,7. Les papiers exempts de traces d'acide libre présentant des valeurs du pH de 6 á 7 ont une durabilité supérieure. Toutefois le pH de papiers exempts d'acide, non tamponnés baisse vers la limite dangereuse en raison de son contact avec une atmosphère polluée et de l'auto-acidité engendrée par des phénomènes d'oxydation. Des traces de métaux agissant comme catalyseur d'oxydation accuroissent l'oxydation de l'anhydride sulfureux en anhydride sulfurique et accélèrent la chute de pH par oxydation directe de la cellulose.

Les acides produits peuvent être neutralisés par la réserve alcaline du papier. Il est évident que cette réserve durera plus longtemps si les traces de catalyseurs métalliques sont supprimées ou inactivées. La démonstration de la présence de catalyseurs d'oxydation et de leur inactivation grâce à un procédé déterminé fait l'objet d'une discussion.

Paper Permanence: A Step in Addition to Alkalization
Beständigkeit von Papier: Ein zusätzlicher schritt zur Alkalisation

Bei einem pH-Wert von unter 4,7 wird Papier schnell spröde. Säurefreies Papier mit pH-Werten von 6 bis ist beständiger. Dennoch fällt der pH-Wert von säurefreien Papiersorten in die Gefahrenzone ab, wenn das Papier verunreinigten Umgebungen ausgesetzt wird und weil intern durch Oxidation Säure gebildet wird.
Spuren-Metallverbindungen, die als Oxidationskatalysatoren wirken, beschleunigen die Oxidation von Schwefeldioxid zu Schwefeltrioxid, und auf Grund der direkten Oxidation der Zellulose wird das Absinken des pH-Wertes beschleunigt.

Durch alkalische Bestandteile des Papiers können die gebildeten Säuren neutralisiert werden. Diese Bestandteile können offensichtlich länger wirksam werden, wenn die Spuren-Metall-Katalysatoren beseitigt oder inaktiv gemacht werden. Die Beweisführung, dass Oxidations-Katalysatoren vorhanden sind und dass ein entsprechendes Verfahren diese inaktiv macht, wird diskutiert.

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Conservation and Softening of Leather in Book Bindings

Konservierung und Weichmachung von Leder-Einbänden

by M. V. YUSUPOVA

Introduction

The changes of leather in book bindings in the process of natural ageing and under the influence of unfavourable storing conditions usually result in the loss of sheen, crumbling of the face layer, increase of stiffness and appearance of fragility.

As the first publication on the damage of leather book bindings one should consider information given by Faraday in 1843 while lecturing at the Royal College of London, where books with seriously damaged bindings were demonstrated. Faraday suggested that this condition of book bindings was connected with the effect of gases absorbed by them from the air. Systematic research of the problem of leather damage was done in the first part of the twentieth century. It was initiated by the British Scientific Research Association of Leather Manufacturers. In 1945 the Association published the results of its research which are now widely used in dealing with the questions of conservation and restoration of old leather.

Among the Soviet research in that direction, that done by I. K. Belaya in the Scientific Research Laboratory of the V. I. Lenin State Library of the USSR is well known.

Short Information on Structure, Tanning and Greasing of Leather.

Leather book bindings are usually made of calf, goat and sheep skins. The skin taken off an animal is a continuous fibrous tissue with innumerable sweat glands and hair roots.

The unprocessed leather has the outer side covered with hair (epidermis), the inner side close to the muscular tissues (subcutaneous cellular tissue) and the part between epidermis and subcutaneous cellular tissue: derma. It is derma which, in the course of processing, becomes leather. Derma consists of a mixture of albumen molecules combined in a particular way, the main component being collagen.

While dressing leather, the hair is removed from the skins; then the skins are freed from fat, neutralized and processed to prevent putrefaction, water pene-

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tration and, at the same time, preserving the natural elasticity. Calcium is used for taking off hair, fats and muscular tissues, and blood vessels are taken away mechanically.

Biological and chemical preservation is reached by means of special substances called tannins. Tannins can be of plant, mineral and synthetic origin. Today the combined tannins are widely used. Still, leather bindings were usually treated with plant tannins and these tannins are therefore of particular interest. Since old times tannins were infusions of oak-tree bark and elguminous acacia. Also extracts from the willow tree, sumakka and gumbira have been widely used. These infusions and extracts have substances which react chemically with the albumen molecules of leather. The material resulting from this reaction has water resistant properties and increased toughness. To obtain the necessary pliability the tanned leather is softened by fat; in other words, it is lubricated with greasing compositions.

According to modern concepts the main aim of using grease is to regulate the degree of clinging together leather fibres in the process of drying.[6]

But regulation of clinging is not the only function of grease. It is well known that while dehydrating wet leather by freezing or by processing it with solvents easily mixed with water (such as acetone), leather preserves softness in its dry condition. However, leather dehydrated with solvent has not as good physicomechanical characteristics as greased leather has, and that can be explained by the pliant effect of grease.[15] The connection between chemical preservation and the presence of grease in leather has not been discovered.[6]

As greasing materials one can use animal fats and oils (stearin, hoof oil); plant oils (corn oil, castor oil, cotton seed oil); fat of sea animals (blubber, spermaceti fat or sperm oil); synthetic fats, mineral oils and sulphanates. Previously, greasing was done by processing the wet leather with a mixture of fats and oils . Today, emulsions of fats and oils in water are widely used in leather manufacturing. Naturally, as fats, oils and water do not mix, emulsions are prepared with the help of emulgators, surface active substances (sulphate fat oils and hydrocarbons), protecting colloids (egg albumin, casein, natural resin) or their combinations.

The significant interest in this research is the problem of substituting natural fats with synthetic substances. Of special interest in this field are studies of chlorinated hydrocarbons (according to Fisher and Tropsh) and their features as greasing substances.[16,7] These products possess a very useful property, resistance to bacteria and to the process of fat efflorescence. But greases of this kind are very expensive which is why they are not used in present practice.

The original method of manufacturing pliant leather was suggested by G.

Fuchs.[8,9] According to this method the wet leather is processed by a high temperature boiling solvent instead of greasing.

Since, while drying, the water evaporates quicker than the solvent, the remained solvent covers the fibres, prevents clinging together and in due course also evaporates. The solvent is the high temperature boiling petroleum fraction of oil with the flash temperature somewhere about 60° C. In addition to the solvent, 1% of strong polared substance is recommended to prevent a rind formation while drying in case the leather once more becomes wet.

It is supposed that alkenil-amber acid or its anhydrid may carry out this function. This method assumes less than 50% of water in the leather before processing it with the solvent.

The method researched by Mr. G. H. Fuchs is not appropriate in the common usage of this word. But since the time of its publication some manufacturers have begun to offer emulsions with the use of standard emulgators, standard oils and up to 50% of high temperature boiling solvents. These substances should provide better penetration of fat into leather. It is believed that such substances may be used for manufacturing especially soft leathers.

Leather Ageing and Conservation

Some changes within leather itself and in the composition of its greasing substances occur in the process of ageing. During this process one can observe a decrease in durability, weight, square, waterwashed substances, the boiling temperature and increase of leather acidity.

Ageing is significantly sped up by storing leather book bindings near heating systems in an area with great humidity or very dry air, especially if the air has a lot of dust or substances resulting from burning gas, coal or petroleum products.

Especially great damage is done by sulphuric acid, which is accumulated in leather because of the catalytic transformation of sulphurous gas absorbed from the environment. Sulphurous gas is practically always in the atmosphere of cities with large industrial complexes and a great number of cars and heavy vehicles. The content of sulphuric acid in leather may total 5% or more. But even 1% of sulphuric acid caused noticeable damage in leather in just one month. It is very important to note here that leather in a dry condition may be preserved quite long but much longer after submerging it in water for some minutes, (sufficient moisturising), if it is significantly damaged.[10]

One should mention two ways of ageing: chemical, connected with the destruction of leather structure; and physical, which usually results in destroying the upper layer making the internal fibres of the leather stiff.

The problem of protecting leather from chemical destruction has not been solved yet. It is only known that inhibiting this process, aside from appropriate storage, can be achieved by the use of some salts, for example, kalii salt of alpha-oxipropion acid. But one can not eliminate, with its use, the accumulation of sulphuric acid. A more effective protection can be done by preventing the oxidation of structural leather elements and sulphurous gas from air by getting rid of the catalytic substances. The research in this direction is known, but the results are not quite satisfactory.

Unlike chemical ageing, physical ageing can be prevented by timely and properly done greasing of leather to prolong its life.

The main function of grease is to regulate the degree of leather shrinkage during the process of drying, but it has only a small effect on plasticity. This is why, while greasing old leather, the main result is to provide its conservation.

As was noted above, book bindings were made with the help of plant tannins. The use of these particular leathers is justified by their ability to soften and be easily processed under wet conditions, to be decorated by gold, impressing or stamping, and also by the high stability of their mechanistic and physical properties. It was discovered that plant-tanned leathers lasted longer than the strong, waterproofed, stringently processed chrome and plant chrome leathers, because after 3 years of storing under normal conditions and also storing under the conditions of increased humidity and temperature, they showed 3 times less decrease in durability.[10]

For leather book binding conservation a great number of lubricating oils, substances and complexes are offered: hoof oil[1], watch oil MBP-12,[11] glycerol, glycerol in combination with castor oil,[3] lanolin, vaseline, mineral oils,[14] soap-oil emulsions, spermaceti emulsions (for white leather)[4] and consistent greases based on mineral and fat oils.

But the lubricant worked out by I. K. Belaya and the leather lubricant of the British Museum (so-called »British lubricant«) are most widely used. The first lubricant is mainly recommended for the processing of black and very dark leathers. In its composition we can find hoof oil and bees wax with a small addition of antiseptics – thymol and antioxigenous oil – paraxidifenilamin. This lubricant allows simultaneous conservation and preventive disinfection of old leathers. Its main property is the ability to spread on different leather levels – the oil penetrating into leather preserves the fibres and provides them with elasticity; the bees wax being spread over the surface to make it water resistant, unaffected by atmospheric humidity fluctuations and also to protect it from crushing.

For coloured and light leathers the most suitable greasing is the so-called »British lubricant« which consists of lanolin, cider-seed oil, bees wax and

hexan; hexan sometimes being substituted by petrolane ether. As a result of mixing these components one gets a yellow lubricant which easily penetrates into leather, but is also highly inflammable, which is why there should be no open fire in the room during its use and for some time after.

Both lubricants should be spread in an even manner, because an abundance of these lubricants may cause darkening of the leather and even fat contamination of the book paper blocks.

The above-considered lubricants may in a certain way be thought the best known substances for leather conservation. But they have a significant fault, because their animal and plant compounds are not chemically stable enough to be permanent. In particular, hoof oil, in spite of the presence of antioxidizer, already during a 3-5 year period significantly changed its characteristics and lost its conserving properties. Therefore it is recommended to lubricate leather book bindings under no less than 5 years.

The development of new leather lubricant concepts along with the appearance of new synthetic materials which simultaneously have greasing abilities and are stable as far as microbic putrefaction is concerned makes the search for new substances providing long-term conservation very necessary.

While searching for these substances one should choose those of synthetic or mineral origin which have the properties of thermooxidizing stability and the ability to lubricate in certain compositions.

Substances based on the above properties should increase the percentage of stringently oxidized lubricant in leather, significantly slow down the process of sulphuric acid formation, glue together the fibrous leather structural elements and thus increase their mechanical durability; moreover they should resist insects and mould growth.

Choice and Testing of Lubricating Compositions for Book Binding Leather Conservation

While choosing the base and composing the complex systems for leather book binding conservation we have tested substances of different chemical natures: synthetic silicon organic liquids-polymetyl and polyethylsiloxans of different viscosity (PMS-250; PMS-400; PES-S-1; PES-S-40); substances of mineral origin – vaseline oil, alkenile amber anhydride (AYaA); fat oil and industrial oil (MBP-12).

The choice of these materials is not casual. Polymethyl and polyethylsiloxans are usually colourless or lightly coloured liquids without smell, having high thermooxidation stability and low evaporation. Vaseline oil has analogue properties. AYaA is very interesting for research because of the published literature on its ability to decrease leather shrinkage while drying. Testing results of fat oils are given for comparison because of their wide use in the practice of leather conservation.

Consistent greases have been prepared on the base of the above-mentioned liquid substances by mixing them with different condensers. Lanolin, ceresine, petrolatum and spermaceti were used as condensers; for humidification bees wax was added. The properties of lubricants and their effect on leather were compared with the corresponding results of previously worked out mixtures on the base of hoof (bone) oil. While characterising the properties the colloid stability was determined by the use of standard methods as well as the temperature of condensate dropping, the acidity number, the soaping number, the percentage of water in a substance.

Besides this we took into account its action on the cover paint, the ability of being spread over the surface, the ability after being spread to paint the paper. The influence on paint and the ability to be spread over the leather surface were determined organoleptically, and the ability to paint the paper was estimated with the aid of photometric measurements of paper samples light passing coefficient, the paper having been for a specified time (30-60 days) in contact with lubricated leather under pressure (150 kg/m^2).

The experiment was held on new leather by plant tanning, old leather book covers of the XVII-XIX centuries and leathers of book covers of the XX century being stored under favourable conditions – (under long-time high relative air humidity and in areas under water).

Liquid lubricants and greases were spread by tampons on the surface of the leather; for better diffusion, new leather's surface was previously processed with acetone (the covering film was taken away). In a day the lubricated samples were polished with woollen tissue.

The effect made by lubrication substances on leather was estimated by the changes in its physical-mechanical and physical-chemical characteristics – tensile strength, elasticity (relative elongation), hygroscopicity, acidity, etc. All these measurements were done in accordance with the methods of testing shoe materials and shoes.

Analyses of literature data[1,2] and results of our experiments showed that light and heat have a weak influence on leather properties if they influence separately. For this reason the speeded leather ageing was done by a combined method suggested by Czechoslovak specialists: leather was kept in thermostat (temperature 35-37° C) and relative humidity 95-98% (7-12 days) and after that processed by ultra-violet radiation (80 hours) and again kept in thermostat (7-14 days).

The testing showed that thin lubricants under research practically didn't

influence durability, hygroscopicity and acidity of leather, slightly increased elasticity and significantly decreased moisture drying. Moisture drying decreases while stable hygroscopicity will slow down leather drying, i.e. will practically provide its conservation. Due to the fact that a minimum of moisture drying effect was observed while using pure vaseline oil, it was chosen and given priority for preparing consistent conservation greases. The necessity for the development of greases is explained by the fact that thin lubricants, oils in particular, cause significant darkening of leather and sometimes affect even fly-leaf paper and lists of book blocks.

Vaseline greases with satisfactory colloid stability were accepted only with the use of petrolatum and ceresine. Along with condensers, bees wax was added to some compositions. It was discovered that greases without ceresine had optimal properties. The presence of ceresine increases hygroscopicity, or, in other words, makes leather more perceptive to atmospheric humidity fluctuations. Previously recommended fat lubricant based on hoof oil has the same effect on leather as the above-described vaseline lubricants.

The vaseline lubricant of optimal composition (vaseline oil – 40%, bees wax – 20%, petrolatum – 39%, AYaA – 1%) is a homogeneous cream of light or dark brown colour. Unlike the fat grease it has practically no smell, does not effect the non-processed leather areas which reduces the danger of contaminating a bookblock, and after being spread over leather makes no print on paper; but its more valuable advantages are the following: higher colloid stability and smaller percentage of free and non-free acids. Due to this the new mineral lubricant can provide more continuous conservation. The price of the new lubricant is 5-7 times less than the price of lubricants used nowadays.

The V. I. Lenin State Library of the USSR has innovated the new lubricant into the practice of leather bookcover and binding conservation and is going to increase this practice.

Softening of Book Binding Leather

The use of lubricants, greases and oils on leather, as it was shown by the results of the experiments, provides conservation but has no softening effect. But sometimes softening is of extreme importance for leather bookcovers and binding restoration. In connection with this we have studied previous literature[11] on possibilities of softening the overmoisturised old bookcover leathers by processing with an inert abrasive followed by oil impregnation.

For the research, leather was taken off the covers of bindings, then moisturized with distilled water, the glue layer carefully scraped away by bone or glass, after which filtred sulphurous water was used and a great amount of vaseline oil was spread over on the flesh side.

After 14-16 hours, the leathers were put under a press. The leather was wrapped in filtre paper which was periodically changed. The time period under the press was determined by the time necessary for getting rid of the fat print on fresh paper which was in contact with the leather for 12 hours.

After pressing, the leather was additionally processed by an abrasive on the flesh side. The characteristics of the leathers measured by us at different stages of softening showed that mechanical processing led to some decrease of their thicknesses, because of partial scraping of fibres and extraction of the glue layer. However, the durability was not practically changed. Hygroscopicity and acidity also remained permanent. In the use of vaseline oil one can observe the extreme growth of elasticity and simultaneously, moisture drying decreases which prevents leather from drying. Thus mechanical processing in combination with the application of appropriate lubricating material provides significant softening and conservation of leather.

One of the necessary operations in softening is moistening. Moistening is also necessary for the elimination of deformations. But, according to literature data[8] some water-soluble substances which are components of old leathers, protect them from chemical destruction, and the washing out of such substances is certainly undesirable.

Due to this in restoration laboratories while washing leathers, the solutions of table salt are often used instead of water. For definition of the usefulness and effectiveness of the application of table salt solutions we have studied the influence of half an hour action of water and water solutions of NaCl (5-10%) on the content of general water-washed substances in new leathers of plant tannins and old bookcover leathers. The measurements of water-washed substances were done in accordance with the standard method (GOST 938.-68) accepted for leathers. As a result of tests done it was discovered that the content of water-washed substances in new leathers is affected by their being in water. In old leathers it is either not changed at all or decreases.

In the case of using NaCl solutions the quantity of water-washed substances as a rule increases, especially rapidly in new leathers (5 times). This shows that the use of such a solution does not prevent washing out the protecting salts from leather, but leads to penetration of NaCl into them. Nevertheless, due to the fact that NaCl does not inhibit ageing, its storing property in leathers, from our point of view, is not obligatory. Thus, short-time wet processing of leather without the application of table salt solutions is quite acceptable.

Summaries

The author gives short information on structure, tanning and greasing of leather; analyses the causes of leather ageing in book bindings, as well as features of materials used for their conservation.

The author proposes new preservation lubricants made on the basis of mineral substances; shows its advantage in comparison with earlier known materials.

He gives the methods of softening old dry leather using water, inert abrasive, and hard oxidized oils.

Conservation et assouplissement du cuir des couvertures de livres

L'auteur donne des informations brèves concernant la structure, le tannage et l'enduction de graisse des cuirs. Une analyse des causes du vieillissement des couvertures de livres est présentée, de même que des caractéristiques des matériaux utilisés en vue de leur conservation.

L'auteur propose des lubrifiants de conservation nouveaux produits à partir de substances minérales. Les avantages retirés sont comparés aux produits anciens connus.

L'auteur indique une méthode d'assouplissement de vieux cuirs secs en utilisant de l'eau, des abrasifs inertes et des huiles fortement oxydées.

Konservierung und Weichmachung von Leder-Einbänden

Der Autor gibt einen kurzen Abriss über Struktur, Gerben, und Schmierung von Leder, er analysiert die Ursachen für die Alterung des Leders in Bucheinbänden sowie die Merkmale der Materialien die für die Konservierung dieser verwendet werden.

Der Autor schlägt die Verwendung von neuen Schutz-Schmier-Mitteln vor, die auf der Basis von Mineralstoffen hergestellt werden. Wir werden mit den Vorteilen dieser gegenüber bisher bekannten Materialien bekanntgemacht.

Er stellt dar, wie altes, trockenes Leder durch die Verwendung von Wasser, einem träger Schleifmittel und hartoxidierten Ölen weichgemacht werden kann.

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Biological Principles of Book Keeping Conditions

by J. P. NYUKSHA

Temperature and humidity conditions are most important for book preservation. To protect books against the attack by fungi, it is first of all necessary to be guided by the physiology of these organisms and the properties of paper associated with the aqueous regime of the medium. The susceptibility of paper to the attack by fungi is dependent on the lower limit of relative air humidity at which destruction begins and the rate and length of the process development.

The limiting values of humidity and temperature for spore germination and colonisation of fungi on cellulose materials[1, 2, 3, 4, 5, 6] have long been found. The spores of many fungi most often germinate at a relative air humidity of 80-100 %. However, in the case of long-term storage the materials revealed spore germination of the Aspergillus and Penicillium at 70-75 % and even 60 % relative air humidity[7].

Fungal growth results in the beginning of moisture liberation. The destruction of fibres leads to the fact that more than half of the cellulose remains in the material in the form of water: during decompositon of 1 g of cellulose, 0.55 g of water is freed. The accumulation of water by a colony makes it become independent of the relative air humidity. Therefore, the importance of the moisture condition which is crucial for spore germination is somewhat weakened during subsequent growth of fungi.

The viability of fungi in book stacks is, in turn, dependent on changes in the moisture content of paper which is the base and nutrition substrate for their growth.

Paper is a very complex hygroscopic system with inhomogeneous capillary properties[8, 9]. Depending on the kind and method of fibre treatment, amount and quality of adhesives and fillers, mode of making and drying, art of coating, and the conditions of use the ultimate moisture content of paper and its changes are established. The role of ingredients in paper composition may briefly be characterized as follows. Cellulose, especially native wood cellulose, is a more hygroscopic product than pearl fillers; therefore, the higher the ash content of paper, the less the moisture capacity. The content of hemicelluloses in wood pulp and wood cellulose also contributes to high hygroscopic capacity. This is why daily paper (with wood pulp content equal to 60-80 %) has a much higher

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equilibrium moisture than cotton paper. Bleaching reduces the equilibrium moisture content.

Cyclic changes in high humidity and drying periods have an adverse effect on the hygroscopic properties of paper: much of the tension arising during paper making disappears and the contraction of paper is reduced[10]. During long-term keeping in inadequate conditions, paper is subjected to the same effects but with moderate parameters. The result achieved is the same: any kind of paper after long-term storage reveals reduced hygroscopic properties and contraction. This is always observed in practice: the paper of old books has properties that are different from those of unused paper of the same kind[11].

The modes of sorption and desorption of moisture by paper are not similar, and hysteresis occurs: the curves of moisture desorption by paper usually follow above the curves of adsorption. The predominance of water uptake inherent in paper over water desorption is enhanced when it is combined with films and other materials. Thus, paper desorbs moisture more rapidly and more completely than polyethylene-impregnated paper. Ultimately the equilibrium humidity in this material is equalized. Similar changes also occur in fungal contaminated paper. The compact mycelium structure on the surface and inside the paper makes it hydrophobic on drying: affected paper may be hard to impregnate with water, while places heavily covered by mycelium can be moistened only by using surfactants. The water-repellant capacity of these fibres is additionally enhanced by fat formation inherent in some fungi.

Thus, the physico-chemical and biological aging of paper leads to a similar change in its ability to hold water.

Paper contains water in various forms. Adsorption, *colloidal water*, which is closely associated with fibre by means of hydrogen bonds is almost inaccessible to fungi because it does not have the properties of liquid water and does not determine the humidity regime of paper for organisms. At the same time, colloidal water is most significant in determining fibre properties: it influences the swelling degree of fibres. The most important for fungi is *capillary water* which fills in all of the paper's spores. This water is liquid water. It has little influence on the swelling capacity of fibres and is readily responsive to humidity changes. Capillary water provides conditions for fungal growth. Part of capillary water, *imbibed water*, fills in the lumen and coarse visible pores. This water is responsible for the establishment of the saturation point. This water is also very important for fungi, but it can both facilitate and prevent their growth.

For normal growth, fungi require a definite amount of oxygen in the substrate. They are aerobic organisms and therefore under saturation conditions they grow slowly. Fungal colonisation on sized paper is better because the paper porosity and air permeability are higher, aeration capacity is better and

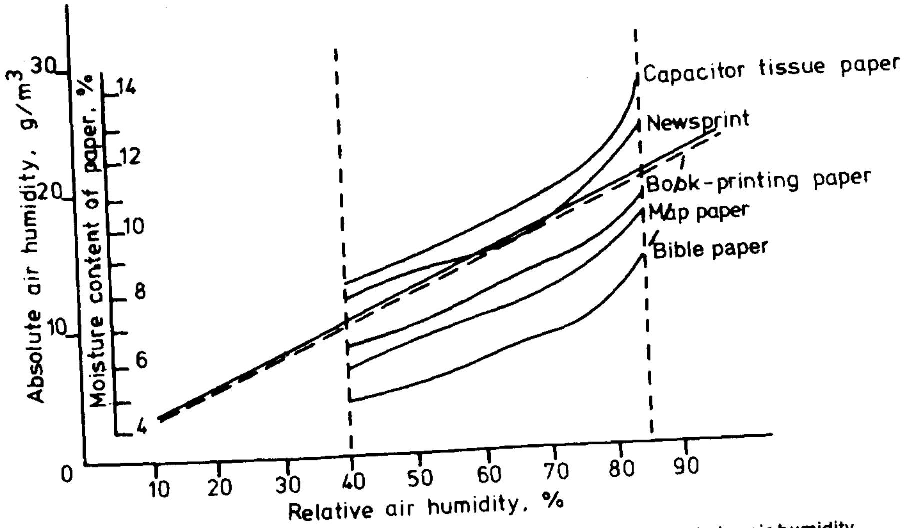

Fig. 1: Relationship between equilibrium moisture content of paper and relative air humidity.
Fig. 1: Relation entre la teneur d'équilibre en humidité et l'humidité relative de l'air.
Abb.1: Beziehung zwischen dem Gleichgewichts-Feuchtigkeitsgehalt von Papier und der relativen Luftfeuchtigkeit.

water penetration is worse. This paper has adsorption water and capillary water in small amount, whereas imbibed water amount is quite limited: it can only penetrate into parts with insufficient amount of colophony. Enhanced fungal growth is observed after the paper is subjected to the effect of temperature in the case of artificial aging. This is also associated with changes in the aqueous regime in paper. During the drying of paper, there occurs the formation of hydrogen bonds between the hydroxyl groups of cellulose and water molecules. This is also followed by the swelling of resin sizing. In unsized paper there exists the first of the factors above, whereas in sized paper both factors take place simultaneously. As the result, in both cases fungal growth is enhanced. The physiology of fungi revealed is exhibited in the selectivity with respect to the physical properties of paper. For example, *Stachybotrys chartarum* (Ehr. ex Lk.) Hughes, *Stemphylium botryosum* Wallr., *Ulocladium chartarum* (Preuss) Simmons, *Vericillium tenerum* Nees ex Lk., *Sporotrichum bombycinum* Cda. spreading on the paper surface prefer the humidity-stable middle part of a sheet. Conversely, *Myxotrichum chartarum* Kunze et Schm. ex Fr. and *M. defexum* Berk are localized only on well aerated margins and book cut edges, etc. On the whole, the dependence of the viability of fungi on capillary water in paper is in its own way revealed in each case of the combination of the art of paper with the physiology of fungi. For scientific explanation of this, the limiting parameters of

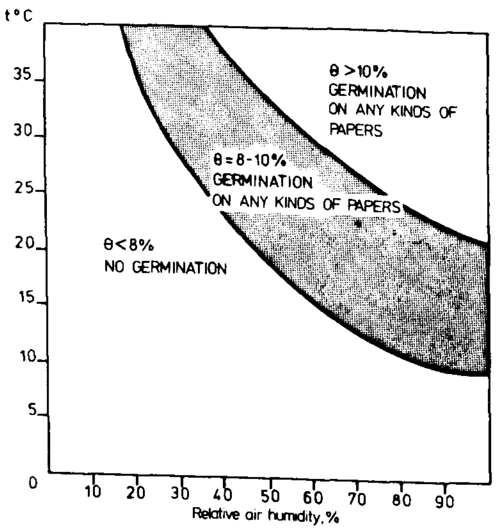

Fig. 2: Relationship between capillary moisture capacity of paper θ and spore germination of fungi.

Fig. 2: Relation entre la capacité d'humidification capillaire du papier et le développement des spores fongiques.

Abb. 2: Beziehung zwischen der Kapillar-Feuchtigkeits-Kapazität von Papier und der Keimung der Pilzsporen.

temperature and humidity allowing fungal growth should be made dependent not on the relative air humidity (as is often done), but on the absolute moisture content of paper in the presence of capillary water.

The smallest critical equilibrium moisture content (whose increase leads to the occurrence of capillary water) for cotton products and paper is 8-10 %. Nevertheless, during storage of materials in practice it is necessary to measure the temperature and relative air humidity; therefore, it is very important to establish as far as possible the relationship between these parameters.

For many kinds of paper in normal condition the equilibrium moisture content in a range of 45-60 % at a temperature of 24°C is 4.5-9 %. The moisture content of different kinds of paper shown in Fig. 1 has been established using the sorption isotherm typical of capillary-porous colloidal materials. The rising curve of the moisture content up to the relative air humidity of 75 % follows at an angle of 15-20° with respect to the abscissa axis. In an interval between 75 and 85 % there occurs a sharp and rapid increase in the equilibrium moisture content of paper from 6.5-10.5 % to 8.5-14 % and the curves rise at an angle of 45-50° with respect to the horizontal axis. It is therefore not accidental that the critical moisture content for spore germination occurs when the relative air humidity is 75 %.

Different kinds of paper have an equilibrium moisture content of 8-10 % determining the limits of possible fungal growth within 50 % relative air humidity for capacitor tissue paper to 85 % for Bible paper. Knowing the dependence between the temperature and absolute and relative humidity of air it is possible to relate these parameters to the equilibrium moisture of paper.

The moisture level of 8-10 % can be reached for different kinds of paper at a moisture content of air equal to 8 to 19 g/m^3. In the system of rectangular coordinates shown in Fig. 2 are given dependences limited by the relative air humidity of 0 to 100% along the abscissa axis and along the ordinate axis by the temperature and relative air humidity determining the absolute content of moisture in the air at which for the kinds of paper used for writing and printing an equilibrium moisture content of 8-10 % will be reached. The nomogram obtained forms three regions of parameters.

Region I is limited by the abscissa and ordinate axes and by the curve that passes along the line of 8 % moisture content taken to have maximum moisture capacity. In this region, fungi cannot grow on paper at all. To a temperature below 10°C this region extends to all values of the relative air humidity. In these limits is confirmed the regime taken for the keeping of paper within a temperature range of 14-22°C and relative air humidity of 45-65 %.

Region II is bounded by the curve of the lower limit of spore germination on paper having maximum moisture capacity at 8 % moisture content and by the curve of the upper limit of fungal growth on Bible paper (of minimum moisture capacity) at 10 % moisture content. At each point of the parameter of this region fungal growth on some kinds of paper is possible.

Region III is limited by the curve of the upper boundary of the critical moisture content of Bible paper and the line perpendicular to the abscissa axis at the point of 100 % relative air humidity. In this region fungi can affect any kind of paper.

The data presented above show a very significant range of changes in the parameters favoring the growth of fungi on various kinds of paper and allow the following conclusions:

1. The possibility of fungal growth is determined by the relationships between moisture adsorption and desorption by various kinds of paper and the quantitative relation in it of various forms of water: colloidal, capillary and imbibed water.

2. The most important quantity characterizing the conditions for the growth of fungi is the absolute moisture content of paper.

3. The minimum critical equilibrium moisture content of 8-10 % at which spore germination is possible occurs in various kinds of paper within 14-22°C at a relative air humidity of 45 to 90 %.

4. In the system of rectangular coordinates, there are three regions of parameters relating the temperature to the relative humidity where at each point the spores of fungi can: (a) remain incapable of germination, (b) germinate only on a certain kind of paper, and (c) germinate on any kind of paper.

Biological Principles of Book Keeping Conditions

Summaries

To protect books against the attack by fungi it is necessary to be guided by the physiology of these organisms and the properties of paper associated with its aqueous regime. The moisture capacity of paper changes during long-term storage and under the influence of biological damage. Paper contains water in various forms. Fungal growth on paper depends first of all on the presence of capillary water and on the absolute moisture content of paper. The minimum critical equilibrium moisture content at which spore germination is possible occurs in various kinds of paper at a relative air humidity of 45 to 90% and, accordingly, at a temperature 14-22°C. In the system of rectangular coordinates, there are three regions of parameters relating the temperature to the relative humidity where at each point the spore of fungi can: (a) remain incapable of germination, (b) germinate only on a certain kind of paper, and (c) germinate on any kind of paper.

Principes biologiques s'appliquant aux condition de conservations de livres

La protection des livres contre les attaques des champignons nécessite de recourir à la physiologie de ces microorganismes et aux propriétés du papier associé à son régime d'équilibre en milieu aqueux. La capacité d'absorption du papier change durant un stockage prolongé et est fonction des dégâts d'ordre biologique. Le papier contient de l'eau sous des formes diverses. La croissance fongique sur du papier dépend au premier titre de la présence d'eau capillaire et est fonction de la teneur absolue en humidité du papier. La teneur minimale en eau d'équilibre critique pour laquelle la germination des spores est rendue possible se situe dans divers types de papiers à une humidité relative de l'air de 45 à 90% et une gamme de températures concomittantes de 14 à 22°C. Une représentation graphique révèle l'existence de 3 zones de paramètres reliant la température à l'humidité relative pour lesquelles, en chaque point, les spores fongiques peuvent présenter: a) une incapacité permanente de germination b) une germination valable sur certains types de papier c) une germination valable sur tous les types de papier.

Biologische Prinzipien der Erhaltung von Büchern

Um die Bücher gegen den Angriff von Pilzen schützen zu können, muss man sich von der Physiologie dieser Organismen und den Eigenschaften von Papier in Verbindung mit dessen Verhältnis gegenüber Feuchtigkeit leiten lassen. Die Feuchtigkeitskapazität von Papier verändert sich während der langfristigen Lagerung und unter dem Einfluss von biologischer Zerstörung. Papier kann Wasser in verschiedenen Formen enthalten. Das Pilzwachstum auf Papier ist in erster Linie von dem Vorhandensein von Kapillarwasser und dem absoluten Feuchtigkeitsgehalt des Papieres abhängig. Der minimale kritische Gleichgewichts-Feuchtigkeitsgehalt, bei dem das Keimen der Sporen möglich ist, liegt bei verschiedenen Papiersorten bei einer relativen Luftfeuchtigkeit von 45 bis 90% und einer Temperatur von 14 - 22°C. In dem rechtwinkligen Koordinatensystem treten drei Parameterbereiche auf, die Temperatur und relative Luftfeuchtigkeit verbinden. An jedem dieser Punkte können die Pilzsporen: a) nichtkeimungsfähig verbleiben, b) nur auf einer bestimmten Sorte Papier keimen, c) auf jeder Papiersorte keimen.

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Some Regularities of Book-Storage Contamination by Insects

Quelques régles concernant l'infestation des locaux d'entrepôt des livres par les insectes

Regelmässigkeiten beim Befall von Buchbeständen durch Insekten

by Z. P. DVORYASHINA

For effective protection of library stocks from damage by insects, their development, the places of their location in book collections, the connections of insects with natural environment and also the peculiarities of libraries (situation and location, transmission of the stock, the total number of loans, number of readers per day, the peculiarities of the library material itself) . . . the availability of sufficient information on these questions would allow justifiable planning for measures to exterminate the vermin and to prevent contamination.

The study of the vermin in libraries deals mainly with the ascertaining of the species composition of the insects [1, 6, 11, 12, 13] and the research of the biology and the perniciousness of separate species.[2, 3, 4, 5, 8, 9, 10]

The book damage by insects is the result of their occasional appearance in the library as well as the result of contamination of the book stock itself.

For many years we have been observing a multistoried book-storage which is characterised by a great variety of stocks, from the point of view of the materials as well as their usage.

As a rule a certain temperature and humidity being kept in the book-storage is the reason why the development of the insects may occur without diapause during the whole year. But it was observed that in spring and in autumn insects have periods of more pronounced activity, especially those species which live under natural conditions. Such activities as far as the obligate sinantrops are concerned are not connected with the season, but depend on the development of every concrete population in a certain environment.

Due to precisely determined periods of insects' activities in book-storages one can observe their mass appearance especially when the nidus exists in the book-storage.

The appearance is often transitory, which is why a successful and rapid extermination depends greatly on the insects being discovered at the appropriate time.

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It was also noticed that the presence of the niduses with the vermin is closely connected with the conditions of book-storing. Neglect of the hydrothermal and hygienic regime of storing creates a favourable condition for the insects' development.

Continuous observation of the book-storage demonstrated the changes in the species composition of the vermin. Up to the 'forties and 'fifties one of the most common vermin was the drugstore beetle *Stegobium paniceum* L (Coleoptera, Anobiidae).

In comparison with other insects 90 % of the contaminated books were contaminated by this beetle. The drugstore beetle affected mainly the ancient books, the bookbindings of which have a lot of paste. Other kinds of this beetle such as *Anobium punctatum* Dey, *Xestobium rufovillossum* De Geer and *Ernobius mollis* L were not met very often.

As was shown by the results of book-storage inspections during the last years, beetles from the family of *Coleoptera, Dermestidae* began to predominate in species and in quantity.

	1962	1963	1964	1965	1966	1967	1969	1970	1971	1972	1973	1974
The total number of vermin found	5	10	0	5	4	4	4	12	25	59	45	9
Among them:												
genus *Anthrenus*	0	0	0	2	0	2	2	14	23	34	23	4
genus *Attagenus*	2	0	0	2	2	0	4	7	22	22	18	5
genus *Dermestes*	2	1	0	0	0	0	1	1	0	2	2	0

Beetles from Coleoptera, Dermestidae, as a rule, totalled not less than 50 % of vermin found, but during the last six years all the insects found were from that family.

The number of insects from other taxonometric groups is not large:

Coleoptera	97.90%	from the total number
Anobiidae	3.30	–
Dermestidae	90.20	–
Ptinidae	0.55	–
Tenebrionidae	3.85	–
Lepidoptera	1.55	–
Psocoptera	0.55	–

The previously predominating drugstore beetle and other beetles were found as single beetles, despite the fact that they could, as well as Coleoptera, Dermes-

tidae normally develop while eating substances with 8–12 % water. The exceptions in this family are representatives of the genus Dermestes, which need more than 15 % of water in substance.

In the beginning of the 'sixties the small black beetle from the Tenebrionidae family appeared in libraries; this beetle being a serious threat to different kinds of products and materials.

The beetle and larvae of this species in book-storages are able to eat different sorts of paper, leather and calico book covers. But the quantity of these beetles has not become significant. During the last years' inspections we did not discover it; in the period of the vermin's appearance in book-storages it was often found in large quantities in households.

In our opinion the reason for the appearance of this beetle in libraries was caused by its being brought in with personal things of library employees.

But there were no appropriate hydrothermal conditions for the insects' development because humidity rarely reached 75 %, which is optimal for this insect's development.

The change of the vermin species in the book-storage should be explained by their ecological peculiarities.

In comparison with the larva of Coleoptera, Anobiidae the larva of Coleoptera, Dermestidae has the possibility of actively finding its natural habitat and food due to its greater mobility.

In comparison with other vermin the beetles of this family are exclusively stable to the influence of unfavourable factors of the environment.[7]

Under natural conditions they do not suffer from captors and parasites. They are able to develop on substances with a small amount of water, and can also overcome the significant rise of humidity in air and food. Moreover, many of the species continue to live actively within broad temperature ranges (from – 15° up to +50° C).

The representatives of *Attagenus* and *Anthrenus* can live without food during long periods of time.

According to our observations under laboratory conditions larvae resume their normal living activities after 10 months' starvation.

The beetles of the genus *Dermestes* have no such peculiarity. We can find only one representative of this genus in the library – *D. lardarius* L – larder beetle.

Due to this particular reason and also due to the fact that the larder beetle is dangerous as a beetle as well as a larva, while in *Attagenus* and *Anthrenus* only the larva is dangerous (beetles do not eat at all or eat nectarus and flower pollen), this, in our opinion, explains the quantitative predominance of the insects of two of the above-mentioned genera in book-storages.

The most numerous among them are *Anthrenus picturatus* Sols and *Attagenus*

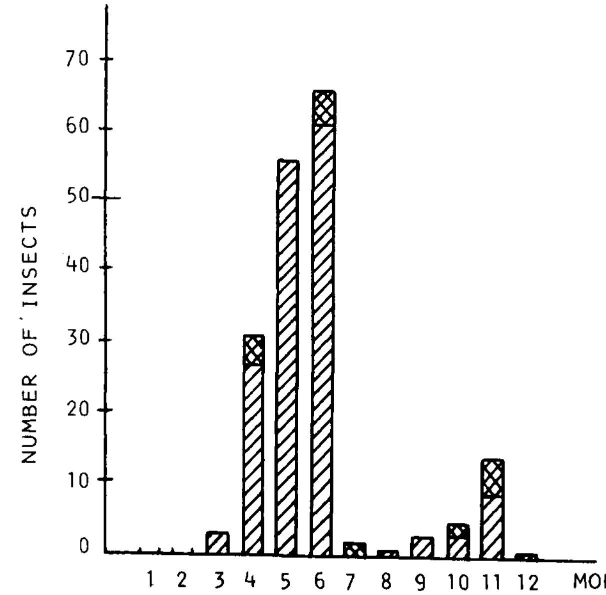

Fig. 1: The appearance of insects in the book-storage depending on the season.
Fig. 1: Dénombrement des insectes dans les entrepôts de livres en fonction de la saison
Abb.1: Das Auftreten von Insekten in Bücherbeständen, in Abhängigkeit von der Saison.

smirnovi Zhant. During the last ten years of all the Anthrenus beetles discovered in book-storages *Anthrenus picturatus* Sols totalled 85.1 %. Among the genus *Attagenus, Attagenus smirnovi* Zhant's share is 62.3 %.

These insects are new to the regions of moderate climate. The first species is an insect characteristic to southern regions of the Soviet Union (Central Asia and the Caucasus), the second one was brought from abroad.

The insects accomodate themselves to new conditions quite rapidly and today the damage done by them is larger than from the local species.

R. D. Zhantiev[7] calls attention to the fact that one and the same species of Coleoptera, Dermestidae in different regions can do damage in different ways and in unequal grades.

Out of the natural areas of living one species quickly dies, the other accomodates itself to living in households, but is not able to live in a natural environment, the third fully accomodates itself to climatic conditions of the new area of living and sometimes does more damage than in its native land. Therefore, while inspecting the book-storages it is very important to determine the species of insects found, to know the areas of their inhabitancy and to find out their connection within the natural environment of vermin.

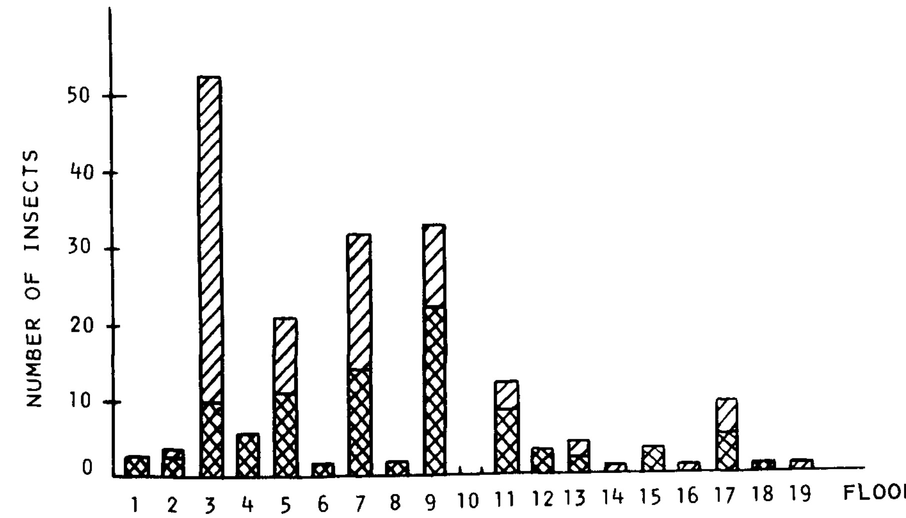

Fig. 2: Distribution of insects in the book-storage levels.
Fig. 2: Répartition des insectes dans les divers étages des entrepôts de livres
Abb. 2: Die Verteilung der Insekten auf die verschiedenen Etagen von Bücherlagern

The appearance of beetles in libraries may be observed already in April. But the most active appearance is in the second part of May, and in the first part of June. The main mass of insects consists of the beetles of two genera: *Attagenus* and *Anthrenus* which as a rule are found when inspecting the book-storages. In spring larvae become chrysalises and beetles appear. They are positively phototoxic, which is why they can often be found on windows and in other well lighted places of a book-storage.

The probability of finding out the well camouflaged larvae, eggs or chrysalises is very low. The second but very insignificant appearance of beetles is observed in autumn (Fig. 1).

In a book-storage different stocks are affected by vermin unequally (Fig. 2). The greatest number of insects was found on the third level of the book-storage; twice less than this number – on the fifth, seventh and ninth. On the eleventh level one can find one insect per annum on the average. On the upper levels the number of insects is insignificant in comparison with the low levels.

A certain increase of vermin was observed on the seventeenth level, and that happened because of removing the books from the eleventh level to this one. A small number of insects was found on the first and second levels because of their being in the basement and being served by a small number of library employees.

One can call attention to the fact that there are a small number of insects on

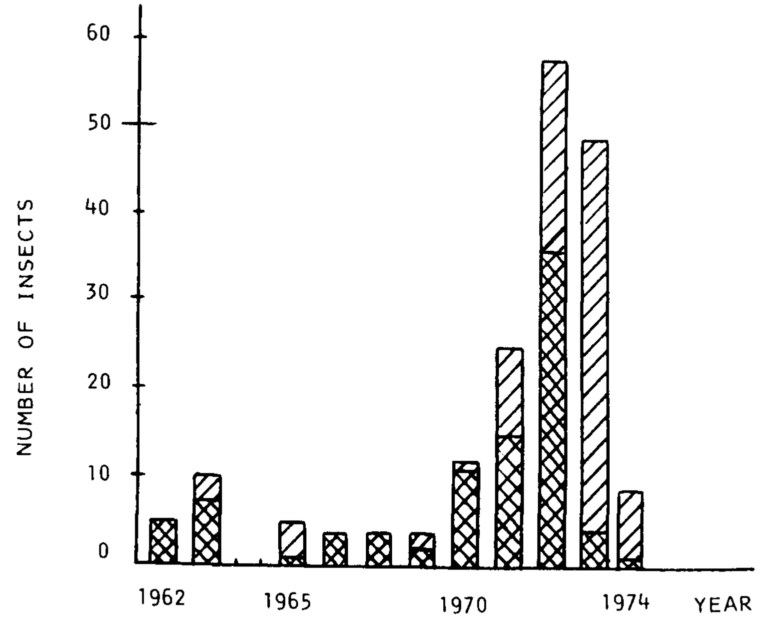

Fig. 3: Number of insects in the book-storage in different years.
Fig. 3: Variation du nombre d'insectes dans les entrepôts de livres en fonction des années.
Abb.3: Anzahl der Insekten in Bücherbeständen in verschiedenen Jahren

even levels; this is because these levels have no solid floors, i. e. they are separated from the lower level by metal gratings. The most contaminated third level has the passage. The above-marked distribution of insects on the levels is quite justified.

Insects appear in the book-storage through the windows opened for ventilation: the main mass of vermin, being as a rule in imaginal stage, was collected near the open windows. Many species of vermin are found in birds' nests and on plants. Insects fly in the lower level of air and that is why only few of them can be found higher than the tenth level of a book-storage.

Insignificant contamination on all levels is also kept by the book traffic within the book-storage.

The fluctuations of the number of insects was marked in different years and that is explained not by biological peculiarities of vermin, but by sanitary-hygienic conditions of stock and book-storage areas (Fig. 3). In one and the same book-storage up to 1969 the total number of insects discovered during a year was from 4 to 10 (on an average of not more than 5).

Beginning with 1970 one can observe the increase of the number of insects within a period of three years and in every following year the number of insects

doubled. The major part (half and more) were live insects. At the turn of the year 1972–1973, the general processing of the whole book-storage by phosphoroorganic insecticides complex took place. As a result, in 1973 the live insects totaled only 8 % from the total number of the insects collected.

One should take note that all the insects in that year were collected during the first six months.

In 1974 the number of insects rapidly decreased. Besides the effect of insecticides there is another factor which explains fluctuations of the insects' number in the book-storage: at the end of the 'sixties and the beginning of the 'seventies the dust cleaning, for some reason, was not practically done.

Beginning with 1973 the whole stock is now cleaned once a year.

According to the results of book-storage examination we can come to the conclusion of the necessity of library spring screening; and the book-storages with the greatest number of readers and small book traffic need the most degree of attention. To prevent book-storage contamination and to decrease the insects' number it is necessary to clean the household carefully, to make regular examinations and to clean the stock from dust.

Summaries

In order to effectively protect library collections from damage by insects it is necessary to know the ecology and etology of the insects, their development, places of their location in book storages, the connections of insects with the natural environment as well as the peculiarities of the book storages (situation and location, collections movement, the volume of book charges, readers' attendance, the character of the library materials). The availability of sufficient information on these questions allows for planning measures aimed at the extermination of the vermin and prevention of library contamination.

Quelques régles concernant l'infestation des locaux d'entrepôt des livres per les insectes

La protection efficace des collections de livres de bibliothèque contre les dégâts causés par les insectes implique la connaissance de l'écologie et de l'étologie des insectes, de leur développement, des sites d'implantation dans les locaux d'emmagasinage des livres, des relations existant entre les insectes et les sites d'implantation narurels réservés ainsi que des particularités inhérentes aux magasins de stockage des livres (situation et disposition, déplacement des collections, ampleur des frais, fréquentation du public, type de matériaux des bibliothèques). La disponibilité d'informations suffisantes concernant ces questions permet de concevoir des mesures justifiées en vue d'exterminer la vermine et de prévenir la contamination des bibliothèques.

Regelmässigkeiten beim Befall von Buchbeständen durch Insekten

Um die Sammlungen in Büchereien effektiv gegen Schäden durch Insekten schützen zu können, ist es notwendig eine lange Reihe von Faktoren zu beachten: die Ökologie und Ethologie der Insekten, ihre Entwiklung, ihre Aufenthaltsorte in Bücher-Magazinen, die Verbindungen der Insekten mit

den natürlichen Bedingungen und den Besonderheiten der Bücher-Magazine (Lage, Bewegung der Sammlungen, Büchermenge, Besuch durch Leser, Charakter der Materialien der Bücherei). Wenn zu all diesen Fragen umfangreiche Informationen vorhanden sind, können gezielte Massnahmen eingeleitet werden, um die schädlichen Insekten auszurotten um den Befall der Büchereien zu verhindern.

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Some Remarks of a Microbiologist on Protection of Library Materials against Insects

Quelques remarques présentées par un microbiologiste sur la protection des documents des bibliothéques

Einige Anmerkungen eines Mikrobiologen über den Schutz von Bücherbeständen gegen Insekten

by ROMUALD KOWALIK

The problem of insects and insecticides relates to microbial decomposition of library materials, since insects bring on their bodies spores of fungi and Actinomycetes and may constitute potential danger of decomposition of old documents and books. It seems also that in the alimentary tract of some insects and of their larval forms cellulose and collagen-decomposing microorganisms exist.

Generally speaking a temperature of 25°C and a relative humidity of 75 % are the best conditions for the development of all insects. Therefore special care must be given to temperature, ventilation, light and cleanliness of libraries and archives. There exist however insects for which paper, leather, parchment, adhesives, textile and wood, are natural nourishment[5]. These insects may develop in storerooms of libraries even when climatic conditions are unsuitable for them.

Silverfish, bookworm and cockroaches can be controlled by spraying the walls, woodwork, floors, ceilings and the cupboards with insecticides, as parathion and malathion in deodorised kerosene or using dusting powder containing pyrethrum flowers, or pyrethroids/DDT; dieldrin or chlordan are too persistent poisons and they are discouraged in different countries by Environmental Protection Agencies. See Table 1.

Ethylene oxide is the most suitable insecticide for fumigation of library materials. When 90 % carbon dioxide is present or about the same percentage of various fluorinated carbons the resulting mixture can in turn be mixed with air in all proportions without passing through an inflammable state. Carbon dioxide is a cheaper diluent, but because of its vapour pressure, its mixture must be contained in expensive steel cylinders. The fluorinated mixtures, while more expensive per kg, can be kept in inexpensive throwaway metal containers. The mixture of 40 % ethylene oxide and 60 % methyl bromide (weight per volume) is nonflammable[13].

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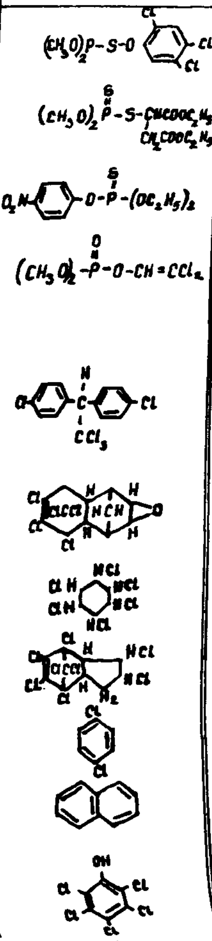
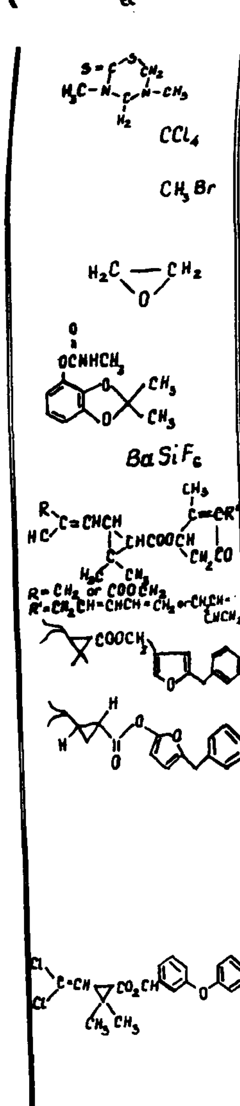
Table 1. Insecticides les plus importants préconisés pour la protection de matériaux de valeur.
Table 1. The more important insecticides proposed to protect valuable materials.
Tabelle 1. Die wichtigeren Insektizide für den Schutz wertvoller Bestände.

Structural Formula	Chemical Name	Trade or Common Name	Field of Application	Melting point	Colour	Solubility	Toxicity	Note
	dimethyl 2,4,5-trichlorophenyl phosphorothionate	ronnel	wood, cellulosic materials lacquers, varnishes	41°C		in water 1:250 at 25°C, soluble in most organic solvents	LD50 1740 mg/kg to rats p.o.	
	S-(1,2-bis)ethoxycarbonyl (ethyl) O,O-dimethyl phosphorodithionate	Malathion	wood, cellulosic materials, lacquers	b.p. 156-157°C	yellow liquid	in water 145ppm, miscible with many organic solvents	LD50 to rats 480-5800 mg/kg	
	O,O-Diethyl-O-p-nitrophenyl phosphorothionate	Parathion	wood, cellulosic materials	b.p. 375°C	yellow liquid	in water 20-25 ppm, soluble in alcohols, esters, and aromatic hydrocarbons	LD50 to rats 6,4 mg/kg	
	O,O-Dimethyl-O-2,2-dichlorovinylphosphate	DDVP Dichlorvos	wood	b.p 120°C	white liquid	in water 1 percent, moderately soluble in kerosene, mineral oil, miscible with aromatic and chlorinated hydrocarbon solvents and ethanol	LD50 to rats p.o. 56-80 mg/kg	
	1,1,1-trichloro-2,2-bis (p-chlorophenyl)ethane	DDT	cellulosic materials	m.p 108,5°C	white crystalline solid	nearly insoluble in water, soluble in most organic solvents, moderately sol. in oils	LD50 to male rats 113 mg/kg	are discouraged in different countries by the Environment Protection Agencies
	1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octa-hydro-1,4-endo-exo-5,8-dimetanonaphthalene	dieldrin	cellulosic materials	m.p. 175-176°C	crystalline	soluble in water negligible, moderately soluble in most organic solvents except aliphatic oils and methanol	LD50 to rats p.o. 100 mg/kg	
	1,2,3,4,5,6-Hexachlorocyclohexane (mixture of isomers)	BHC, HCH			commercial product grey or brownish	in water 10 ppm	LD50 to rats p.o. 125 mg/kg Lindane	are discouraged in different countries by the Environment Protection Agencies
	1,2,3,5,6,7,8,8a-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene	chlordan			viscous amber liquid	insoluble in water, miscible with most organic solvents	LD50 to rats p.o 457-590 mg/kg	
	p-Dichlorobenzene	Paracide, PDB	Commonly used to protect fabrics and clothing	53°C	crystals white	very slightly soluble in water and alcohol, soluble in most organic solvents	LD50 to rats p.o. 2,56 g/kg	fumigant
	naphthalene	naphthalene	commonly used to protect fabrics and clothing	80°C	white crystals	insoluble in water, low solubility in alcohol, freely soluble in most organic solvents	No mammalian toxicity	fumigant
	pentachlorophenol	PCP, penta	wood, sizes	191°C	pure compound white crystals	soluble in most organic solvents	LD50 to rats p.o. 210 mg/kg	sodium salt is water soluble
	3,5-dimethyl-1,3,5,2H-tetrahydrothiadiazine-2-thionate	Dazomet	wood, cellulosic materials	100-103°C	white crystals	slightly soluble in water, alcohol and benzene; freely soluble in acetone and chloroform	LD50 to rats p.o. 650 mg/kg	
	carbon tetrachloride	Perchloromethane	ethnographical materials	b.p. 76°C	colourless liquid	low solubility in water, soluble in most organic solvents	general anaesthetic	
	methyl bromide	Bromomethane	different materials		colourless gas	1,34% at 25°C in water	respirators must be worn at conc. over 17 ppm	fumigant
	1,2-epoxyethane	Ethylene oxide Carboxide	different materials	b.p. 10,7°C	colourless liquid	Miscible with water and organic solvents	Concentrations above 3000 ppm dangerous if inhaled for 30 minutes or more	
	2,2-dimethyl-1,3-benzodioxolo-4-ilo-N-methylocarbamate	Ficam bendiocarb NC 6897	against cockroaches and other pests destroying materials, wood, plastics, rubber				LD50 to rats 179 mg/kg	
	Barium fluorosilicates		against silverfish, cockroaches destroying cellulosics			slightly soluble in water, soluble in dilute acids, ammonium chloride solution	LD50 to rats 175 mg/kg	
	Mixed esters of pyrethrolone and cinerolone with chrysanthemic and pyrethric acids	pyrethrum	wood, paper, leather, parchment textiles			in water negligible	LD50 to rats 800 mg/kg p.o.	
	5-benzyl-3-furyl-methyl (±)-cis, trans-chrysanthemate	resmethrin					LD50 to rats 4240 mg/kg p.o.	
	5-benzyl-3-furyl-methyl (+)trans chrysanthemate	bioresmethrin	against cockroaches in sewers and waste chutes				low	in practice 0,15% bioresmethrin + 0,15% piperonyl butoxide
		cisresmethrin NRDC 119	ditto				low	as a fog 0,5% (w/v) in a concentration 1 litr on 100-200 cm³ more effective than bioresmethrin and dieldrin
	racemic ester (3-phenyl benzyl (±)cis, trans (20:80) 2,2-dimethyl-3-(2,2-dichlorovinyl cyclopropane carboxylate)	permethrin NRDC 143	ditto				low	activity close to that of bioresmethrin with considerably greater stability in light 30× more effective than dieldrin and 100× more effective than DDT

The fumigation of different materials (including collagenic) may be accomplished by placing the infected material in a tightly closed container with a tray containing *p*-dichlorobenzene. Such an atmosphere will kill all winged insects and larvae in twenty-four hours, but the box should not be opened for three weeks to insure that larvae subsequently emerging from eggs are also destroyed. This is a slow process but the probability of controlling the insects is great.

It was shown that the vapour of dichlorvos (2-dichlorvinyl dimethylphosphate) released slowly from Vapona strips was completely effective in preventing both emergence of adult *Anobium punctatum* from infested paper and wood and hatching the eggs. The application rate using one strip on 4 m^3 was twice that recommended for control of other insects. According to Harris and others[7] annual exposure of dichlorvos strips during the emergence period should give practical control of infestation by *Anobium punctatum* and give protection against initiation of attack. One strip on 28 m^3 is effective.

As was also found[12], Ficam-bendiocarb (2,2-dimethyl-1,3-benzodioxolo-4-ilo-*N*-methyl carbamate) is effective against cockroaches and other pests. Bait trapping barium fluorosilicates and barium carbamates were also proposed for control of silverfish and cockroaches. But from an ethical point of view dichlorvos, toxic to humans, and especially Ficam as possible carcinogen are too dangerous.

Silica aerogel and boric acid against cockroaches were carefully studied as insecticides and because they offer sufficient safety margins to the human population and sufficiently long activity of residues, they may be advised to protect valuable objects. They penetrate through the chitin layer of insects to their alimentary tract[6].

From an ethical point of view pyrethroids seem to be the most suitable insecticides as chemical spraying or powder. They do not damage valuable materials and they offer sufficient margins to the human population, as all natural insecticides are of low mammalian toxicity, both oral and dermal. The rapid metabolism degradation of pyrethroids contribute to their low toxicity. These compounds do not irritate or sensitize the skin. Inhalation and dermal toxicity are low and pyrethroids are not mutagenic or tumorogenic[9].

One of the most interesting new insecticidally active chrysanthemates effective against cockroaches and other insects is resmethrin; bioresmethrin with piperonyl butoxide as synergist as thermal fog was blown into sewers and waste chutes to control cockroaches in Singapore in 1973, then cismethrin, permethrin, which can be used in the form of fumigant, having a rapid knock-down effect on cockroaches, termites and others[1,2,3,4,8,11,15]. It was also found that bioresmethrin was 50 times less toxic to rats than cisresmethrin[14]. Prentiss Drug and Chem. Co., New York[10] offered a new insecticide based on 2 %

pyrethrin and two synergistic compounds, "Prentox", which kills cockroaches, silverfish, ants and spiders.

The following insecticides seem to be admissible from the ethics of a conservation point of view: ethylene oxide, *p*-dichlorobenzene, boric acid with silica gel, and bioresmethrin. They do not damage precious materials, they offer sufficient safety margins to the human population both oral and dermal and inhalation of these biocides is low toxic, and boric acid, *p*-dichlorobenzene and bioresmethrin are not mutagenic or tumorogenic[9]. The conditions of the preservation of library materials are of course the most critical points for a long life of our cultural heritage, and relative humidity in the store-rooms and reading rooms should not be higher than 50–63 %, temperature 14–18°C and precious materials should not be exposed to the action of UV.

Summaries

Insects which destroy library and archive materials have been mentioned. More attention was paid to the insecticides, used in gaseous form as well as chemical spraying and powder. The best insecticide for fumigation of library and archive materials (excluding parchment material, collagen of which may be partly depolymerized) is undoubtedly ethylene oxide. Out of the contact insecticides the most suitable seem to be pyrethroids, as they do not damage valuable materials, they are of low mammalian toxicity and not cancerogenic and do not sensitize the skin. They are also not harmful to the environment, because they are rapidly decomposed by chemical and biological agents.

Quelques remarques présentées par un microbiologiste sur la protection des documents des bibliothèques

Les insectes responsables de dommages survenant aux documents des bibliothèques et des archives ont été passés en revue. L'article traite au premier titre d'insecticides employés sous forme gazeuse ainsi que sous forme de dispersions chimiques et de poudres. L'insecticide convenant le mieux à la fumigation de documents de bibliothèques et d'archives – à l'exclusion du parchemin dont le collagène risque d'être partiellement décomposé – est sans aucun doute l'oxyde d'éthylène. Abstraction faite des insecticides de contact, les préparations à base de pyrèthre semblent être les plus adaptées, elles évitent tout endommagement de matériaux de grande valeur; leur toxicité à l'égard des mammifères est faible, le pouvoir cancérigène et la sensibilisation de la peau à leur contact sont nuls. Ces produits n'exercent pas d'effet préjudiciable sur l'environnement du fait de leur décomposition rapide par les agents chimiques et biologiques.

Einige Anmerkungen eines Mikrobiologen über den Schutz von Bücherbeständen gegen Insekten

Insekten, die Bücherei- und Archivbestände zerstören, sind behandelt worden. Näher hat man sich mit den Insektiziden beschäftigt, die gasförmig sowie als chemische Spraymittel oder Puder zur

Anwendung kommen. Das Insektizid, das am besten zur Desinfizierung von Bücherei- und Archivbeständen geeignet ist (ausgenommen ist Pergament, dessen Kollagen teilweise depolymerisiert werden kann) ist ohne Zweifel Äthylenoxid. Pyrethrin ist von den Kontaktgiften das geeignetste. Es zerstört die wertvollen Bestände nicht, ist für Säugetiere fast nicht giftig, es ist nicht krebserregend und nicht hautempfindlich. Diese Gifte wirken sich nicht schädlich auf die Umwelt aus, da sie durch chemische und biologische Mittel schnell abgebaut werden.

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Report of a Meeting

Conference on Book Paper and Book Preservation

New York, NY May 14, 1979

While the discussion can be summarized, the character of the problem cannot be reduced to a simple statement. If nothing else, the meeting underscored the fact that the number of pertinent issues is large and they are interrelated in complex ways. The present period is a dynamic one so far as this topic is concerned, and the time may be right to make progress, even though a fully effective capacity to work towards improvement in some areas may not now exist. The best hope, perhaps, is to expand understanding of the nature of the problem and to press for specific improvement as opportunities develop. As is always the case , the key question is who will assume that responsibility. If the concern is important, and clearly it is, then the search for ways to reduce the problem of book deterioration to acceptable dimensions must be led by those who feel the concern and have the obligation to act. The probability is that many individuals from paper manufacturing, publishing, and libraries will have to make *themselves* accountable if further progress is to be made.

We emphasize that it is *further* progress that is needed. Past attention to this topic has generated interest, has provided a factual base on which to build, and has prompted development of preservation programs in a number of libraries. There is more paper of high quality made now than at the turn of the century and papermaking skills continue to be refined by research and technology. In short, there is a foundation on which to build.

It should be noted that several related and important topics (retrospective preservation, microfilm standards, etc.) surfaced and deserve attention but limitation of time forced discussion back to the agenda proper. In considering the fundamental question of the importance of extending the useful life of books, participants concluded that it is reasonable to seek a proper balance between the physical durability of books and their intellectual and cultural

Editor's note: This meeting held in New York, May 14th, is the latest in a series initiated by the Council on Library Resources. The story of the Council's efforts to introduce and promote the use of permanent/durable book paper up to 1970 is described by Verner W. Clapp in *The story of permanent/durable book-paper, 1115 – 1970,* Copenhagen 1970 (Restaurator Supplement 3, pp 40–51). The present report is reprinted from Library of Congress Information Bulletin August 3, 1979.

worth. No one was ready to add books to the growing list of society's expendable supplies.

The questions, and the main comments they provoked, follow.

QUESTION 1: Is book paper that meets reasonable specifications for permanence and durability readily available in sufficient variety and at acceptable costs?

1.1 The general subject was put in perspective by certain facts. Of 65 million tons of paper produced in the U.S. annually, only 15 million tons are »white« paper, that is to say, writing and printing paper. Of this about 0.8 million tons (i.e. little more than one percent of all paper produced) are book paper and a substantial portion of even this amount is of lower quality geared to publishing mass market paperbacks. Thus, »book paper« for the books with which libraries are most concerned represents a very small portion of total production and is of minor economic importance, industry-wide, though it constitutes a large part of the output of some manufacturers. For further perspective, it was noted that a single newly installed papermaking machine has a typical capacity of about 100,000-150,000 tons of paper annually.

1.2 With few exceptions, demand for paper of most kinds exceeds supply and this situation is likely to prevail for at least several more years. Capital for expansion of production is being diverted to modify plants in order to meet environmental standards. Publishers currently find that they must take available paper.

1.3 The term »reasonable specifications« was not made more specific, but discussion indicated that the specifications detailed by the Barrow Laboratories are too demanding. Specifications developed by the National Historical Publications and Records Commission were distributed as an example of workable guidelines that may meet requirements for »permanency« yet are realistic, technically and economically, from the point of view of paper manufacturers and publishers. Other agencies and foundations need to include similar specifications in publication support programs.

1.4 Alkaline paper for journals is not now available in the quality required at an acceptable cost. Simply because of the sheer quantity of paper consumed, the economics of journal publishing is very sensitive to paper cost. Any premium in paper price might jeopardize the journal itself, yet the problem of durability must be met.

1.5 There is some growing pressure to recycle paper products but there is skepticism that this effort will solve the problem, though recycled materials may rise modestly above the present United States figure of 22 percent. The growing number of »additives« (coatings and plastics) used in paper manufacture curtails reuse.

1.6 Light weight, acid-free paper (»bible paper«) is in very short supply and is exceptionally costly.

1.7 There is some prospect that the process of paper manufacturing, for both economic and environmental reasons, might be undergoing a major change with the result that substantially increased quantities of alkaline paper might be produced. There was no firm information about either the extent of or the timetable for this prospective change.

QUESTION 2: If such paper is available, why is it not more generally or universally used for publication of books and journals?

QUESTION 3: If appropriate papers are not readily available, or if other obstacles exist, what action is required? By whom?

3.1 Alkaline paper in adequate variety and sufficient quantity and at a competitive price is not as available as it might reasonably be expected to be for book publishing and is clearly not available for journal publishing. In addition to the scarcity situation, other factors (market information, costs, etc.) are also of influence.

3.2 The interest of libraries concerning paper characteristics are not well known to most publishers and are almost unknown to paper manufacturers. Library concerns need to be carefully stated and brought effectively to the attention of publishers and more of the smaller or specialized paper manufacturers. The market needs to be defined and reasonable specifications agreed on.

3.3 There is likely to be little support for raising standards of quality by Government publishers because quantities are so large and the countervailing pressures to reduce costs are dominant.

3.4 Most libraries know little or nothing about the quality of the paper used in books they acquire. Sampling approaches, provision of information in the book itself, testing services, etc., were among ideas advanced that might usefully increase understanding.

3.5 A paper distributed prior to the meeting proposed development of appropriate standards and use of copyright as a device to promote adherence to those standards, either in initial publishing or through a system of complementary publishing. The concept of standards development and voluntary compliance (probably using American National Standards Institute procedures and its Committee P or Z-39) received support. There were mixed views (and some strong opposition) on using copyright as the activating device.

QUESTION 4: What categories of books and journals should be routinely manufactured with high priority given to factors assuring permanence and durability?

4.1 It was suggested that the number of copies printed on alkaline paper that libraries would require, in the interests of retaining permanently a »record copy« of each item published, was actually very few. The implicit difficulties of determining accountability for maintaining the permanent copies of specific titles were underscored. Technical approaches were considered (conversion of text to film, capturing machine-readable copy, etc.) The prevailing sentiment suggested that many books and journals are intrinsically of continuing importance and their utility and availability over time should not be jeopardized by paying insufficient attention to their physical properties, including paper and binding, and the conditions under which they are kept. Not only research libraries of record, but libraries of many other kinds, as well as the individual book purchaser, have a right to a sound product.

QUESTION 5 : How can the use of alkaline and durable book papers be promoted outside the United States?

5.1 Strong and visible evidence of American concern demonstrated by taking effective action to improve book paper and to use alkaline paper in publishing will be the most powerful means to stimulate parallel efforts in other countries. The fact that books and journals are an international commodity means all countries benefit from progress in one.

5.2 It is probable that the International Federation of Library Associations and Institutions (IFLA) should be asked to consider ways to address the topic at the international level.

5.3 The process of developing working standards is international in essence, and might, with time, be a force for voluntary compliance by paper manufacturers and publishers, worldwide. ANSI adoption of standards judged acceptable by libraries and publishers might expedite international action.

QUESTION 6: Can copies of books for libraries be separately manufactured?

6.1 There was little detailed discussion but an initial reading suggests that the possibility exists, either by the original publisher or perhaps by a specialty firm that would republish to specifications the books of many primary publishers. The prospect of binding books to library specifications by the primary publisher also seems possible though it creates additional inventory and fulfillment problems.

At the conlusion of the discussion those present encouraged the continued pursuit of issues identified during the meeting, and a committee was formed to propose procedures for identifying objectives and options for action, to recommend ways to arrive at acceptable standards, and to extend understanding and wider recognition of the problem itself.

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Editorial Notice

RESTAURATOR, *International Journal for the Preservation of Library and Archival Material*, will bring original papers on the subjects mentioned in the titles (including etchings and engravings), as well as reviews and news of interest to scientists, conservators, archivists, and librarians.

Contributions will be accepted in English, French, or German. Abstracts and figure legends will be printed in these languages. Contributors not writing in their mother tongue are particularly asked to have their manuscripts checked for linguistic and stylistic errors.

Manuscripts should be original typescripts (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 the title, position and working place of the author.

An abstract of no more than 200 words should be sent with the manuscript. The abstract should be in the same language as the article. The publisher will provide translation into the two other languages, of the abstract and the figure legends.

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 in the engraving should be inked in black. In general, photographs should be about 1 1/2 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. It is marked in the manuscripts 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.

E.g.: 1. Barrow, W. J.: *Restoration methods.* American Archivist 6 (1943): 151–54.

Authors alone are responsible for the opinions expressed in their papers.

50 offprints of each article will be sent to the author free of charge. Extra copies, if desired, will be supplied at a special rate.

Editor's Address

Manuscripts and review copies of books should be sent to the editor: Poul A. Christiansen, Librarian. University Library: Scientific and Medical Dept., 49 Nörre Allé, DK-2200 Copenhagen N, Denmark.

RESTAURATOR

Editorial Notice

The subscription rate for RESTAURATOR has remained unchanged since 1969 in spite of an increase in the production costs for scientific journals of more than 300 %. This has necessitated increasing the 1979 subscription rate from D.kr. 125.– per volume to D.kr. 260.–, making a 260 % increase in the subscription price.

However, the steadily increasing number of subscribers will be a stabilizing factor contributing to keeping the subscription rate at a reasonable level. Thus, the subscription rate will remain for 1980 as for 1979.

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