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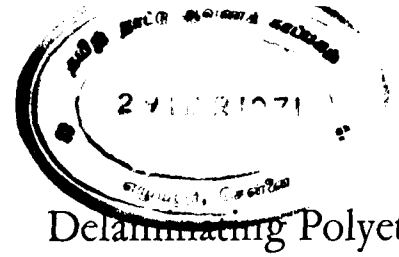

Techniques of Delaminating Polyethylene Laminates

by VERA DADIC & TATJANA RIBKIN

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Today, when an ever increasing number of documents to be restored is being laminated, the importance of the reversibility of this process, i.e. the delamination of a laminate, is growing rapidly, too. In fact, the basic principles of restoration[1] require that every method be such as to permit the restitution of the document into its original state, without any damage.

In restoring documents by lamination the first materials to be employed (and still the most widely used) were various films based on cellulose acetate,[2] the advantages and disadvantages of which have often been described. The majority of these articles derives from detailed and precise experiments by W. K. Wilson and B. W. Forshee.[3] It is widely known that in practice all types of cellulose acetate films used for lamination can be removed from the laminate by means of acetone at room temperature.

The use of polyethylene for the lamination of records is relatively recent;[4] but polyethylene has up to the present date shown a number of excellent properties. First, the mechanical properties of the documents improve significantly, while the laminates are softer and more elastic than those laminated with cellulose acetate. The sickness of the laminated document increases only slightly. Besides, polyethylene film is more readily available and cheaper than cellulose acetate, especially in countries where cellulose acetate suitable for the lamination of documents is not produced.

The polyethylene is polyolefin, chemically neutral; the cold water extract of a polyethylene film has a pH of 6.78, remaining the same even when the film is aged. As all polyolefins, polyethylene is liable to oxidative-degradation, due to elevated temperature or ultraviolet light (thermo-oxidative or photo-oxidative degradation, the mechanism of which is essentially the same). In both cases the primary products of the reaction are hydroperoxides, changing during secondary reactions into aldehyde and ketone groups. The products of the oxidative degradation of polyethylene are acetaldehyde, acetone and vinyl radicals.[5] So we see that neither polyethylene, nor the products of its degradation, can cause damage to the

documents, and consequently cannot accelerate the spontaneous degradation process in cellulose.

During the manufacture of polyethylene the adding of a plasticizer is not necessary, as is the case with cellulose acetate. This means that the negative consequences of the change of the physical properties of the thermoplastic mass, due to the oozing of the plasticizer, are eliminated in advance, as well as the danger of the destructive action of the decomposition products of the plasticizer. The film has little permeability for gases and water vapor, so that it guarantees protection against atmospheric pollutants and humidity. In addition, polyethylene is biologically considerably more stable than cellulose acetate.[4]

Polyethylene is now being widely used in Yugoslavia, due to the initiative of E. Verona in the Library Material Restoration Laboratory of the National and University Library in Zagreb.[6] In order to test various types of cellulose acetate and polyethylene, Mrs. Verona carried out a series of experiments, gaining decisive arguments in favour of polyethylene, which she found to improve the mechanical properties of the records to a greater extent, to cause only a slight increase of their volume, to be absolutely transparent and to possess excellent chemical properties.[7]

As frequently mentioned in items in the bibliography 2, 4, 8, the main disadvantage of polyethylene film is the fact that it is rather difficult to remove from the laminate.

As the restoration workshops in Zagreb (in the National and University Library, Archives of Croatia and the Archives of the Yugoslav Academy of Sciences and Arts) use polyethylene in restoring newspapers, modern records written on low-quality paper, and sometimes older, badly damaged documents, we made a series of experiments aimed at answering the question: is it possible to remove the polyethylene film from the laminate? Later on we were forced to remove the film from original laminates (fragments incorrectly arranged and attached when being prepared for lamination). The first experiments and the consequent delamination procedure were extremely successful, so that we consider our experience may be quite useful for workshops using polyethylene in lamination.

It is generally known that at room temperature polyethylene is not soluble in any known solvent. But if the temperature exceeds 70° C., it swells and then dissolves in benzene, toluene, xylene, decalene and carbon tetrachloride. If the solution is cooled polyethylene precipitates in the form of white flakes [illegible].

At first we may consider the fact that polyethylene dissolves at a tem-

perature higher than 70° C. to be rather a minus. However, during the actual delamination of the polyethylene laminates, we realized that the whole process is in no respect more difficult than the removal of a cellulose acetate film by means of acetone at room temperature.

The key problem to be solved before starting to explore acceptable techniques of delaminating the polyethylene laminates was the choice of solvent. As most organic solvents are inflammable, fast evaporating or more or less toxic, we strove to find a solvent that would guarantee maximum security during the process. When determining the suitability of a solvent, our judgment was based on the qualities we regard as essential for the purpose (relative evaporating rate, 1 being that of ether, which is known to be the most volatile; boiling point; allowable concentration of vapours in the air, with special regard to the vapour-to-air proportion, that gives rise to explosion; flash point). All the constants quoted serve to determine the allowable quantity of the solvent in the laboratory atmosphere, and to determine the quantity of that same solvent in the atmosphere under given working conditions. It would probably be usefull to observe some other constants, too, but we believe that the comparison of those quoted for certain solvents will suffice for a meritory judgment on whether a solvent is appropriate for the purpose we describe or not. For clarity's sake we give a table of numerical values of the constants for acetone and all solvents of polyethylene.[10]

Solvent	Relative evaporating rate	Boiling point C.	Flash point C.	The maximum allowable quantity of vapors in air	Limits of vapor-to-air proportion giving rise to explosion
Acetone	2.1	56°	under −15°	200 ppm	2–13 vol.%
Carbon tetrachloride	3.0	76.7°	–	50 ppm	not inflammable
Benzene	3.0	80.1°	−15°	35 ppm	1.4–9.5 vol.%
Toluene	6.1	109–111°	− 7°	200 ppm	1.3–7.0 vol.%
Xylene	13.5	127–159°	23°	200 ppm	3.0–7.6 vol.%
Decalyne	94.0	186–194°	60°	–	–

The data in the table suggest that decalyne would be the most suitable solvent (high boiling point, low evaporating rate, the least toxic of all the mentioned solvents, relatively cheap). However, having found in the literature more examples of benzene being used to delaminate polyethylene laminates, both benzene and decalene were employed in our first experiments. With decalyne the delamination results were the same, but the work was simpler (due to its higher boiling point and lower evaporating rate), so we decided to use decalyne.

The following gives a description of how we delaminated documents laminated by polyethylene and reinforced with Japanese tissue.

Decalyne was poured into an enameled photographic bath (which should only be of slightly larger dimensions than the document itself, in order to economize use of the solvent). The bath was then covered with a glass plate and heated on an electric heater with a thermostat – as used in photography to warm solutions. It is desirable that the heating surface be approximately equal to or slightly larger than the bath, in order to secure a uniform heating of the bath, which should not exceed the optimum temperature. When the temperature of the solvent (decalyne or benzene) has reached approximately 70° C., the document is immersed in the bath (under the glass plate) and heated at this temperature for 5 minutes, or even less, while the bath is gently shaken (or the solution stirred in some other way). Then the document is placed on the glass plate of the workbench, where the Japanese tissue, together with the remains of the polyethylene film, is removed with a scalpel. It must be noted that the evaporation of the solvent which is rather rapid for benzene and reasonably slow for decalyne) and the cooling of the document do not prevent one from continuing to remove the Japanese tissue and the remains of the polyethylene film. As already stated, polyethylene, if dissolved and cooled, precipitates in the form of flakes, in contrast to the cellulose acetate, which reassumes the form of a uniform film. If the film presents undissolved spots, the whole process can be repeated in the same bath. The delamination should be carried out in a fume hood or in a thoroughly ventilated room while observing all the necessary precautions for working with inflammable solvents, especially if benzene is used. – At the same time we checked the effect of the listed solvents on various inks represented on the records (printing inks, iron-gall inks, Chinese ink, aniline inks, etc.). It has been proved that these inks dissolve more readily in acetone and alcohol than in benzene and decalyne. Some inks that tend to smudge in acetone remained stable in benzene, and even more stable in decalyne.

While removing the polyethylene film from the printed (and sometimes from the typewritten) documents, we had numerous opportunities to observe the same phenomenon that occurs during the delamination of cellulose acetate laminates, i.e. at a higher temperature the upper layer of the ink penetrates into the film and is consequently removed together with it. This phenomenon has given rise to a restoration technique known as »print transfer«.[11] However, this fact does not at all impair the legibility of original texts and cannot be considered to represent a danger to delaminated documents.

In our procedure we distinguished between the lamination of records with cellulose acetate, coated with adhesive (00088 Matte) and uncoated, and with polyethylene. Thus we have had the opportunity to examine which of the proposed methods of delamination is most suitable for each type of laminate.

In all respects, a film of cellulose acetate coated with adhesive is easiest to remove. The laminate is immersed in an enameled bath, filled up to a level of 1 cm with acetone, thus acetone consumption depends on the size of the bath, and kept there only until the paste dissolves, but the film is still intact. Then the film can be easily removed by hand with a scalpel or a cotton wad.

It is rather difficult to remove a cellulose acetate film that has been attached to a document without paste. The document must be kept in acetone until the whole film dissolves, and this rarely happens during the first bath; usually it must be repeated twice or thrice, or a substantially larger quantity of acetone must be used. It must not be forgotten that acetone evaporates at a rather high rate even at room temperature, so that a significant part of the solvent is lost. As it is toxic and its vapors in air are explosive a delamination using acetone must be carried out under a fume hood or in a thoroughly ventilated room. Needless to say, acetone dissolves typewritten texts and many aniline inks to a rather large extent.

Having compared the practical aspects, the advantages and the disadvantages of the delamination of polyethylene and cellulose acetate laminates (the latter without paste), we came to the conclusion that both processes are approximately equally difficult.

All who have tried to delaminate the cellulose acetate laminates are well aware of the difficulties arising during this process; they will understand our assertion that the delamination of polyethylene laminates, especially if performed in decalyne, is not at all more complicated. In both cases, all the precautions applicable when working with inflammable solvents must be

observed, keeping in mind that acetone is a great deal more inflammable, volatile and toxic than decalyne, even at 70° C. Due to evaporation, a significant percentage of acetone is lost already at room temperature, while only a small percentage of decalyne evaporates, even at 70° C. In both cases the upper ink layer of the delaminated printed texts is ablated – but the legibility of the records is not impaired thereby; texts written with modern inks are liable to greater or lesser smudging (in our experience acetone and alcohol proved rather more dangerous in this respect). Neither solvent damages the iron-gall ink texts and paper.

Conclusions

To summarise our experience during the practical delamination of cellulose acetate and polyethylene laminates, we conclude that:

1. The delamination of cellulose acetate and polyethylene laminates is possible in every respect.

2. All the techniques of such a delamination are rather complicated and time-consuming; relatively large quantities of solvent are needed.

3. Documents laminated with cellulose acetate film coated with adhesive are easiest to delaminate.

4. It is approximately equally difficult (considering time and materials necessary) to delaminate the polyethylene and the cellulose acetate laminates.

5. Neither acetone nor decalyne damage the paper of the documents. Certain inks smudge more readily in acetone and alcohol than in decalyne and benzene.

6. In both cases the danger of mechanical damage to the records is equal.

Abstracts

The article describes experience in delaminating cellulose acetate and polyethylene laminates, stressing the delamination of the latter. Polyethylene laminates can be delaminated at 70° C. because polyethylene does not dissolve in any known solvent at room temperature. From the wide range of solvents, the authors chose benzene and decalyne. Having compared the complexity of the delamination of polyethylene laminates with that of cellulose acetate laminates, the authors conclude that they are approximately equally difficult. Much simpler is the delamination of cellulose acetate laminates with paste.

The solvents mentioned do not damage paper. Some inks smudge more readily in acetone and alcohol than in decalyne and benzene. The delamination is always accompanied by the ablation of a very thin surface layer of the printing ink (this phenomenon is the basis of the restoration technique called »print transfer«), but the probability of mechanical damage to documents does not depend on whether they are polyethylene or cellulose acetate laminates.

The article concludes that it is in every respect possible to delaminate the polyethylene and cellulose acetate laminates.

Авторы описывают практические данные о деламинации (отстранении) пластических пленок с документов ламинированных ацетатной целлюлозой и полиэтиленом. Главное внимание обращается на полиэтилен.

Деламинация документов покрытых полиэтиленом осуществляется при повышенной температуре, т.к. полиэтилен не растворим при комнатной температуре ни в каких известных растворителях.

От разных растворителей авторы для испытаний употребили бензол (бензен) и декалин. Бензол испытали потому, что он чаще всего упоминается в литературе. Декалин испытали и употребляют потому что по своим свойствам лучше всего пригоден для деламинации.

По сложности процеса, деламинация документов покрытых полиэтиленом приблизительно одинакова с отстранением ацетатной целлюлозы. (Деламинация документов покрытых ацетатной целлюлозой с клеем значительно проще.)

Употребленные авторами растворители не вредят бумаге. Опыты показали что некоторые сорта чернил менее растворимы в бензоле и декалине чем в спирте и ацетоне. При каждой деламиминации является возможность перехода минимального слоя печатной краски на пленку. Между тем это не уменьшает четкость и читаемость напечатанного документа. Возможность механического повреждения документа в процессе деламинации однакова при всех сортах употребленных пленок.

Таким образом деламинация документов покрытых как ацетатной целлюлозой так и полиэтилена вполне осуществима.

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Evaluation of Langwell's Vapor Phase Deacidification Process

by R. N. DUPUIS
J. E. KUSTERER, Jr. & R. C. SPROULL

The seriousness of the problem of deterioration of acid papers is well known to librarians, archivists and conservators, though unfortunately not to most members of the general public. The economic and cultural value of a simple, inexpensive method of deacidifying whole books as well as loose papers would be huge and probably incalculable.

A tantalizingly simple method of achieving such deacidification is by the use of an alkaline gas which would penetrate the pages of a book and permanently neutralize the acid. Such a process has been proposed by W. H. Langwell[1,2] and has created much interest on the part of those directly concerned.

The Langwell process comprises exposing paper in books or as separate sheets to the vapors from CHC (cyclohexylamine carbonate). The CHC may be used in the form of pellets or granules, either in the loose form or as sachets, or as interleaving sheets impregnated with CHC. Details are given in references 1 and 2.

The W. J. Barrow Research Laboratory of Richmond, Virginia, as a part of the research program sponsored by the Council on Library Resources, has made a technical evaluation of the Langwell process using CHC obtained from Russel Bookcrafts of Hitchin, England. A summary of the results follows.

The objectives of the evaluation were:

1) to determine whether treatment of acid paper by exposure to CHC vapor would raise the pH above 7.0, the neutral point; 2) to determine the permanence of pH change and the effects on the physical properties of the paper treated, both at ambient conditions and after accelerated ageing at 83° C. and 3) to evaluate the physiological hazards which may be encountered by anyone who may be exposed to CHC and the vapors arising therefrom.

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There is no doubt that exposure of acid paper to vapors from Mr. Langwell's CHC process, under properly controlled conditions, will raise the pH of the paper. The degree of pH increase will depend on the method of application. *From our own observations, and those of others,*[3] it is apparent that penetration of CHC vapor is indeed limited. It is *therefore quite* necessary to have an adequate exposure of the book papers to the CHC vapors to insure that all pages are neutralized.

Because of this fact, and since Mr. Langwell is quoted that "deacidification cannot go too far"[2] with CHC, we exposed several types of paper in the form of individual strips to CHC vapors in such a way as to maximize the opportunity of the process to achieve the claimed results.

We chose five types of papers for our experiment. They were composed of: (a) chemical wood; (b) chemical wood containing long cellulose fibers; (c) 50% rag and 50% chemical wood and (d) 100% rag at two initial pH values. These papers ranged in initial pH values from 4.4 (acidic) to 7.3 (slightly alkaline). The sample papers were placed in a large, rigid plastic containment vessel with powdered CHC placed in locations above, below and on two sides of the vessel. Since CHC has a low vapor pressure, a slowly revolving fan was mounted inside the vessel (the motor portion of the fan was located outside the containment vessel to avoid any possible increase in temperature from the motor heat). This procedure insured *complete exposure* of the papers to the circulating vapor. The vapor treatment continued for 55 days at room temperature (approx. 24° C.).

The individual who conducted this experiment reported that exposure to the vapors not only was very obnoxious because of the odor, but also that he experienced incipient nausea and dizziness.

After the papers were removed from the treatment vessel, they had obviously lost much of their brightness and the acidic papers had yellowed considerably. This loss of brightness was in part due to destruction of fluorescent brightening materials added to many papers during manufacture.

The pH of the five selected types of paper before and after treatment, including periodic pH determination during the accelerated ageing cycle at 83° C., is recorded in Table I.

It can be seen from this Table that CHC treatment increased the initial pH and that this pH decreased relatively slowly during 12 days of heat ageing at 83° C. The lowest pH observed after this heating period was 6.7 from a paper which had an initial pH of 4.6.

The change in brightness after treatment as well as the brightness diffe-

TABLE I: pH of CHC treated and untreated samples after heat-ageing at 83° C.

Sample no.		*Furnish*	*Unaged*	*2 days*	*4 days*	*6 days*	*8 days*	*10 days*	*12 days*
44	pH before treatment	Chemical wood	4.4	4.5	4.5	4.5	4.4	4.4	4.4
	pH after treatment		7.3	7.1	6.9	7.0	6.8	6.9	6.8
47	pH before treatment	Chemical wood (long fiber)	4.6	4.6	4.4	4.5	4.4	4.4	4.4
	pH after treatment		7.3	7.1	6.9	7.1	6.9	6.9	6.7
50	pH before treatment	50% rag 50% chem. wood	5.0	5.0	4.6	4.6	4.6	4.7	4.8
	pH after treatment		7.3	7.1	6.9	6.9	6.9	6.9	6.8
53	pH before treatment	100% rag	4.7	4.7	4.7	4.8	4.8	4.8	4.7
	pH after treatment		7.6	7.3	7.1	7.1	6.9	6.9	6.8
56	pH before treatment	100% rag	7.3	7.3	7.7	7.4	7.6	7.7	7.9
	pH after treatment		9.2	9.3	9.0	9.5	8.7	9.1	9.1

(One pH determination was made for each ageing period, the samples being cut from several randomly selected tear sheets).

TABLE II: Brightness of CHC treated and untreated samples after heat-ageing at 83° C.

		Average brightness (% reflectance)							
Sample no.	*Furnish*	*Untreated Control*	*Treated Control*	*No. days heat-aged at 83° C.* 2	4	6	8	10	12
44	Chemical wood	80.4 %	71.7 %	69.1 %	70.0 %	67.6 %	68.3 %	66.7 %	66.1 %
47	Chemical wood	82.3 %	71.8 %	68.6 %	67.8 %	65.3 %	66.6 %	64.1 %	65.9 %
50	50 % rag, 50 % chem. wood	84.2 %	74.4 %	71.0 %	71.3 %	69.4 %	69.6 %	68.6 %	68.7 %
53	100 % rag	85.0 %	79.9 %	76.2 %	75.7 %	74.0 %	75.7 %	73.1 %	73.4 %
56	100 % rag	89.1 %	87.8 %	86.8 %	86.8 %	86.2 %	85.5 %	85.3 %	84.8 %

This table indicates a deterioration in brightness due to treatment of paper with CHC and further deterioration of brightness upon ageing of the treated samples.

(Five samples of each paper were tested for each of the ageing periods recorded).

rences observed during the ageing cycle of the treated papers is indicated in Table II. The measurements were made by a reflectometer which determines the surface reflectance of light.

It should be noted that the pH in all the types of paper treated was 10.0 to 10.3 immediately after treatment. The unaged but treated pH reported in Table I was that pH measured after about 6 months storage in a sealed container after removal from the treatment vessel. The delay between paper treatment and paper testing was because of the necessity of purchase and installation of a fume hood which would carry off the obnoxious and toxic vapors resulting from handling and testing of the CHC and the materials treated with it.

In determining the pH of the CHC-treated papers, it was noted that one of the papers, sample no. 47, which was heavily sized with rosin, sank immediately to the bottom of the water in the pH test beaker while the untreated control sample floated and remained difficult to wet. Performance of the Minnesota and Ontario Size Test (a standard test to determine the effectiveness of rosin sizing) indicated that the CHC treatment had a deleterious effect on rosin sizing.

As to the effect of the CHC treatment on fold endurance and tear resistance, Tables III and IV give the data on the basis of test results and subsequently plotted regression lines. Also indicated is the percent retention of fold endurance and tear resistance after heat ageing of treated and untreated samples. It can be seen that the CHC treatment increased the percent retention of fold endurance and tear resistance (after 12 days of ageing at 83° C.) in most cases. The increase of retention was quite substantial in most cases, especially for the acidic, all-wood pulp papers.

To understand the chemistry of the process better and to determine whether toxic cyclohexylamine could be generated upon exposure to air (which contains water vapor except under extreme and abnormally artificial conditions), an additional experiment was performed. Pure CHC is chemically neutral and counteraction of acid conditions in paper logically requires a chemical reaction of CHC with water or water vapor (hydrolysis) to generate cyclohexylamine, which is an organic alkaline substance capable of deacidification.

The experiment used the following procedure. Air saturated with water at room temperature was passed over powdered CHC and the effluent air was passed through a gas scrubber to dissolve any cyclohexylamine which might have been formed.[4] A mild alkaline oil was collected when a concentrated inorganic alkaline extracting solution was used. The extracted

TABLE III: Untreated fold endurance (M. I. T. 1/2 kg. tension). Averaged heat-aged data (83° C.)

Sample no.	Fold	AVERAGE FOLDS Unaged	2 days	4 days	6 days	8 days	10 days	12 days
44	M. D.*	423	355	254	164	103	173	95
	C. D.**	131	103	77	76	51	59	45
47	M. D.	1,396	1,029	832	822	562	406	906
	C. D.	589	288	330	363	277	212	292
50	M. D.	171	151	120	125	89	78	89
	C. D.	61	60	57	52	51	50	N/S***
53	M. D.	7,421	6,874	6,946	7,093	6,345	5,592	5,716
	C. D.	7,660	6,606	6,697	7,142	6,647	6,594	6,597
56	M. D.	7,975	9,118	7,044	7,132	7,155	7,088	6,393
	C. D.	9,453	8,635	9,735	8,500	8,821	9,115	10,200
	CHC treated fold endurance							
44	M. D.	274	266	301	241	247	204	220
	C. D.	82	76	99	82	88	87	71
47	M. D.	1,133	1,109	1,181	1,174	986	990	954
	C. D.	362	488	433	437	395	434	397
50	M. D.	158	165	181	145	125	159	141
	C. D.	53	57	58	58	55	65	58
53	M. D.	8,810	8,225	6,239	7,861	8,387	7,195	7,455
	C. D.	8,991	7,487	8,381	7,252	8,302	7,084	6,841
56	M. D.	10,067	10,930	9,581	9,789	9,739	9,561	9,213
	C. D.	10,199	9,863	10,041	10,068	9,143	8,753	9,411

(Each of the data points included in this table represents an average of fifty (50) samples tested for fold endurance and ten (10) tear tests through eight (8) samples for each tear resistance data point).

*) M. D. indicates: Machine direction. **) C. D. indicates: Cross direction. ***) N/S indicates: No sample.

Untreated tear resistance (Grams, Elmendorf). Averaged heat-aged data (83° C.)

Sample no.	Tear	AVERAGE GRAMS TEAR Unaged	2 days	4 days	6 days	8 days	10 days	12 days
44	M. D.*	64	59	53	49	46	49	42
	C. D.**	53	49	44	42	40	42	36
47	M. D.	72	46	57	58	53	48	56
	C. D.	65	54	47	50	47	49	N/S***
50	M. D.	64	55	57	59	55	54	55
	C. D.	58	46	53	52	50	49	50
53	M. D.	69	67	66	64	63	62	61
	C. D.	72	70	68	67	66	65	65
56	M. D.	71	69	69	69	69	69	69
	C. D.	76	76	76	76	75	N/S***	74
	CHC treated tear							
44	M. D.	51	51	50	49	50	49	49
	C. D.	63	60	61	60	61	59	60
47	M. D.	59	60	61	60	63	59	59
	C. D.	73	77	74	74	75	75	74
50	M. D.	54	53	52	51	51	52	51
	C. D.	64	62	63	62	60	63	64
53	M. D.	69	67	67	69	67	66	65
	C. D.	69	69	69	69	69	68	69
56	M. D.	74	73	73	73	73	72	73
	C. D.	72	73	72	73	72	72	72

(Each of the data points included in this table represents an average of fifty (50) samples tested for fold endurance and ten (10) tear tests through eight (8) samples for each tear resistance data point).

*) M. D. indicates: Machine direction. **) C. D. indicates: Cross direction. ***) N/S indicates: No sample.

material had a boiling point of 135° C., which was only 0.5° C. different than the reported boiling point of 135.5° C. for cyclohexylamine. The material was shown to be a primary amine by application of the Hinsberg

TABLE IV: Percent retention of treated and untreated samples after heat-ageing 12 days at 83° C.

		% RETENTION	
Sample no.	*Fold*	*Before CHC treatment*	*After CHC treatment*
44	M. D.	23%	72%
	C. D.	36%	95%
47	M. D.	66%	82%
	C. D.	50%	99%
50	M. D.	52%	84%
	C. D.	79%	positive slope
53	M. D.	76%	90%
	C. D.	89%	86%
56	M. D.	89%	79%
	C. D.	positive slope	88%

		% RETENTION	
Sample no.	*Tear*	*Before CHC treatment*	*After CHC treatment*
44	M. D.	69%	96%
	C. D.	90%	96%
47	M. D.	78%	99.6%
	C. D.	77%	100%
50	M. D.	85%	95%
	C. D.	86%	99%
53	M. D.	89%	97%
	C. D.	89%	99%
56	M. D.	99%	98%
	C. D.	99%	99%

test (a standard test to indicate the presence of primary amines).[5,8] Infrared spectra of the dehydrated oil and nuclear magnetic resonance spectra of solutions in water and heavy water (D_2O) further pointed to the presence of cyclohexylamine.[6]

Final confirmation of the presence of cyclohexylamine was obtained by preparation of the phenyl thiourea derivative, which melted at 147.5° C. This value was also within 0.5° C. of the melting point recorded in the literature as 147° C.[8] The melting point of a mixture of the known phenyl thiourea derivative and that of the unknown material showed no depression of melting point, which is the classical proof of identity of organic solids.[5,8]

We therefore conclude that cyclohexylamine can be, and probably is, formed from CHC under normal conditions of use.

PHYSIOLOGICAL CONSIDERATIONS

As indicated above, we were concerned that CHC itself might be hydrolyzed by the moisture in the air and in paper to cyclohexylamine. This was predictable on the basis of reactions of organic carbonates (i.e., CHC) with water. Since we proved that toxic cyclohexylamine was formed under conditions simulating those in libraries, it is appropriate to discuss literature references on the physiological effects of cyclohexylamine under the conditions to which librarians and others would be exposed if CHC were used to deacidify books.

In the first place, both CHC and cyclohexylamine have a very disagreeable (fishy) odor. This may be due primarily to the cyclohexylamine itself, since we have no assurance that the samples of CHC obtained from Russel Bookcrafts of Hitchin, England were absolutely pure. This would create an unpleasant atmosphere not only for those handling the material, but also in the stacks of books treated with CHC.

Cyclohexylamine is reported to cause nausea and skin irritation.[7,9,13,14,16,17,18,20,21,22] Nauseous effects were noted by some in our laboratory who were exposed to the vapor of CHC. We experienced no skin irritation because we were careful not to expose the material to skin. Eye irritation has also been reported as a result of exposure to amine vapors.

More importantly, chronic and acute toxic effects have been observed in experimental animals exposed to varying concentrations of cyclohexylamine vapor, sometimes resulting in death. The most complete references on this subject are by G. V. Lomonova,[9,17] who reports that the minimum lethal

dose of inhaled cyclohexylamine vapors for albino mice and rats is 0.1 milligram per liter and 4.3 milligrams per liter respectively, and the maximum tolerated dose is 0.05 milligram per liter and 1.8 milligrams per liter respectively. Lomonova tentatively suggests a maximum permissable concentration of 0.001 milligram per liter of cyclohexylamine in work areas. This author further suggests that handling, inhalation of vapor, skin painting and gastric administration will be harmful. Specific effects on individual organs are also given.

Since these hazardous limits could conceivably be reached during handling of CHC and subsequent deacidification of books by the prescribed method, serious doubt is cast on the safety of its use in accordance with Langwell's suggested procedure.

Other references to the toxic effects of cyclohexylamine are given by Rosenblum and Rosenblum;[10,14] Legator, Palmer, Green and Petersen;[11] Yamamura, Lee and Dixon;[12] E. R. Plunkett;[13] Paustovskaya and Rappoport;[15] Rappoport, Paustovskaya and Lyadenko;[16] The Merck Index;[18] Medical World News;[19] Industrial Hygiene and Toxicology;[20] N. M. Gleason, R. E. Gosselin, H. C. Hodge and R. P. Smith;[21] Handbook of Poisoning.[22]

The following cautionary labeling for containers of cyclohexylamine carbonate (CHC), based on currently available data, is reproduced by permission of John H. Scharmann, Assistant to the Director, Division of Case Guidance, Bureau of Compliance, Food and Drug Administration, Department of Health, Education and Welfare:

"On the main panel:

'DANGER – MAY CAUSE BURNS TO EYES,
SKIN, AND MUCOUS MEMBRANES.'

On an alternate panel:

'Contains cyclohexylamine carbonate.
Use only in well-ventilated areas and avoid breathing vapors.
Wear rubber gloves when using.
Do not get in eyes, on skin, or on clothing.
In case of contact, flush thoroughly with water.
For eyes, get medical attention.
If swallowed, give large amounts of citrus juice or dilute
vinegar and call physician immediately.
Keep out of the reach of children.' "

For the special 'interleaving' paper impregnated with cyclohexylamine carbonate, we would recommend the following cautionary labeling:

On the front panel:

'WARNING – IRRITANT'

On an alternate panel:

'Contains cyclohexylamine carbonate.
Use only in well-ventilated areas and avoid breathing vapors.
Wear rubber gloves when using.
In case of contact with eyes or skin, flush thoroughly with water.
For eyes, get medical attention.
Keep out of the reach of children.' "

At the time of receipt of the above advice from Mr. Scharmann, the safety of cyclamates as artificial sweeteners was being questioned by the Food and Drug Administration. Subsequently, the use of cyclamates has been severely restricted by the FDA. The chemical suspected to be the cause of the hazard is cyclohexylamine, which apparently can be formed in the body after ingestion of cyclamates. Intensive research on the toxicity of cyclohexylamine is under way.

We therefore sought the opinion of Dr. Leo Friedman, Director, Division of Pharmacology and Toxicology, Bureau of Science of the Food and Drug Administration on the hazards of exposure to cyclohexylamine, which we have shown to be present during and after use of the Langwell process. Dr. Friedman's reply was as follows:

"Cyclohexylamine has both carcinogenic and mutagenic potentian, is more harmful than many other amines, and prudence dictates that exposure to cyclohexylamine be avoided. There is as much concern with the potential hazards of exposure to cyclohexylamine by inhalation and skin contacts as by ingestion."

Conclusions

1. CHC treatment of separate sheets of various types of papers increased the pH of book papers.

2. CHC treatment increased the percent retention of fold endurance and tear resistance over untreated samples after equivalent heat-ageing cycles.

3. CHC hydrolyzes to cyclohexylamine, an odorous and toxic chemical, on exposure to moist air.

4. The CHC treatment appeared to destroy the effect of rosin sizing.

5. The CHC treatment decreased the brightness and fluorescence of papers treated.

6. Even if more extensive tests showed that the CHC treatment penetrated all pages of a book reasonably uniformly and no other harmful effects resulted, the toxicity of cyclohexylamine would seem to cast serious doubt on the feasibility of the process despite indicated advantages of increased pH and increased percent retention of fold endurance and tear resistance. It is, therefore, suggested that the users or potential users of the Langwell vapor phase deacidification process form their own opinions on the precautions they must take, not only to insure adequate deacidification, but to avoid possible health hazards to themselves and to those who handle treated books and papers.

Abstracts

The objectives of the evaluation of the W. H. Langwell Vapor Phase Deacidification process were: 1) to determine its effectiveness; 2) to determine the stability of the pH change due to cyclohexylamine carbonate (CHC) treatment; 3) to evaluate the effects of treatment on the physical properties of paper and 4) to investigate the physiological properties of this potentially hazardous chemical – cyclohexylamine carbonate.

Included in our evaluation was the CHC treatment of several representatives types of paper. A description of the types of paper selected for treatment and the results of pH change are shown in Table I. It should be noted that CHC treatment did increase the pH of acidic and non-acidic paper, in our experiments, but the degree of change probably depends upon the method of application and length of treatment time.

Following thorough CHC treatment, electronic brightness measurements were made revealing that the treatment had caused significant brightness loss and considerable yellowing of acidic papers. The effect of treatment on rosin sizing was also determined at this time. Table II shows the percent reflectance of treated and untreated paper surfaces during the subsequent heat-ageing cycle.

Evaluation of physical properties (fold endurance and tear resistance) of treated samples compared to untreated samples before, during and after heat-ageing at 83° C. for 12 days is reported in Tables III and IV. Results of this evaluation showed that CHC treatment had no harmful effect on the paper before heat ageing and that the treatment increased the percent retention of fold endurance and tear resistance after heat-ageing.

Through the use of the infrared spectrophotometer and the nuclear magnetic resonance spectrometer and by application of classic systematic organic chemical analysis, our laboratory concluded that cyclohexylamine carbonate is hydrolyzed by atmospheric moisture to form cyclohexylamine, which possesses carcinogenic and mutagenic potential.

Reported herein are the results of an intensive literature search conducted by this laboratory concerning the toxicology of cyclohexylamine.

The toxicity of cyclohexylamine concluded from our literature search was confirmed by correspondence with the Food and Drug Administration. A statement by the director of the Bureau of Pharmacology and Toxicology is recorded in this report.

In general, our findings indicate that treatment with CHC provided adequate deacidification and prolonged the retention of acceptable physical properties of acidic and non-acidic paper. However, the treatment did result in destruction of rosin sizing, decrease in brightness and yellowing of acidic paper.

In addition, CHC has a disagreeable odor and precautions must be taken to avoid hazardous effects which may be encountered by those who handle CHC or books and paper treated with it.

Оценка метода деацидификации (удаления кислотности) посредством парообразной фазы, предложенного В. Х. Лангвэллом, проводилась с целью определения: 1) эффективности метода; 2) стойкости изменения pH в связи с обработкой углекислым циклогексиламином (CHC); 3) влияния обработки на физические свойства бумаги; 4) исследования физиологических свойств этого потенциально опасного химиката – углекислого циклогексиламина.

Наши исследования включали обработку ряда разновидностей бумаги посредством CHC. Таблица 1 дает описание разновидностей бумаги, подвергнутых обработке, и достигнутые изменения pH. Следует отметить, что согласно нашим испытаниям обработка CHC увеличивает pH кислотной и некислотной бумаги, однако степень изменения pH вероятно зависит от технологии и длительности обработки.

После тщательной обработки CHC проводились электронные измерения яркости, которые показали, что обработка вызвала значительную

потерю яркости и сильное пожелтение кислотной бумаги. Одновременно определялось влияние обработки на канифольную проклейку. Таблица 2 дает процентность отражения поверхностей у обработанной и необработанной бумаги в течение последующего теплового старения.

Таблицы 3 и 4 дают оценку физико – механических свойств (стойкости при перегибе (фальцовке) и сопротивления разрыву) обработанных образцов по сравнению с необработанными, как до, так и во время и после теплового старения в течение 12 дней при температуре 83°C. Результаты оценки показывают, что обработка CHC не оказывает вредного влияния на бумагу до теплового старения и увеличивает процентность стойкости при фальцовке и сопротивление разрыву бумаги, подвергнутой тепловому старению.

Используя инфракрасный спектрофотометр и спектрометр ядерного магнитного резонанса, а также применяя классический метод систематического органического анализа, наша лаборатория пришла к выводу, что углекислый циклогексиламин гидролизуется атмосферной влагой с образованием циклогексиламина, обладающего канцерогенным и мутагенным потенциалом.

При этом даются результаты интенсивных литературных исследований по токсикологии циклогексиламина, проведенных нашей лабораторией.

Токсичность циклогексиламина, доказанная на основании литературных данных, потверждается и нашей перепиской с Департаментом пищевой промышленности и лекарственного сырья С.Ш.А. К нашему отчету приложено заявление директора Бюро по фармокологии и токсикологии С.Ш.А.

В основном, наше исследование показывает, что обработка CHC обезпечивает достаточную деацидификацию и продлевает срок сохранения удовлетворительных физико – механических свойств кислотной и некислотной бумаги. Однако, обработка вызывает разрушение канифольной прокладки, уменьшение яркости и пожелтение кислотной бумаги.

Кроме этого CHC обладает неприятным запахом и требует принятия мер предосторожности во избежание опасных последствии для лиц, работающих с CHC или с книгами и бумагой, подвергнутыми обработке CHC.

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Tear-resistance Instrument

by A. ARAD

Every restorer is aware of the necessity to measure physical properties of paper, in order to achieve some measure of quality-control of the materials and the methods he applies. The high price of most measuring instruments makes their acquirement impossible for the majority of restoration workshops and thus physical tests remain beyond the reach of the average restorer. Yet, many restorers have both the inclination, and the ability to solve the problem of instruments by »Do it Yourself« methods. Of course, the instruments produced this way are inaccurate and unsuitable for research work, but they are more than sufficient for comparative work and for »quality-control« of materials and methods. This viewpoint brought me to construct the instrument described below.

Tear Resistance Measurement – The Elmendorf Instrument

Tear resistance of paper is usually measured by the Elemendorf instrument. That instrument is a pendulum-type instrument working in the following way (Fig. 1):

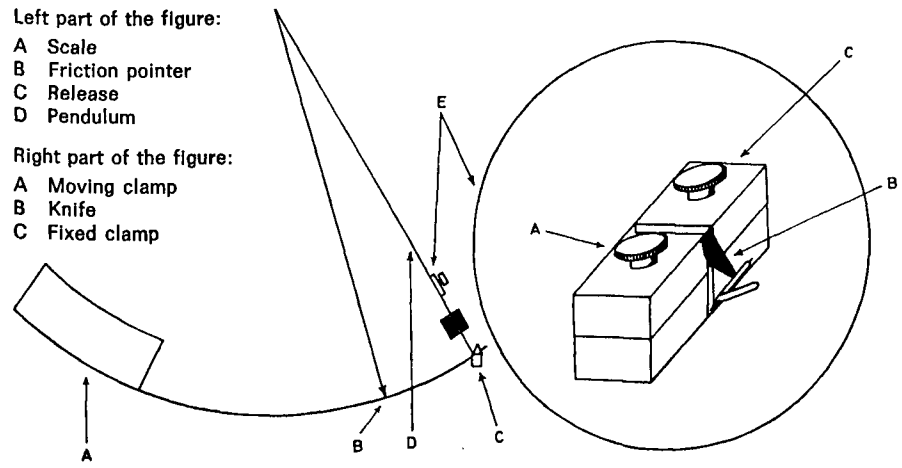


FIG. 1. A schematic representation of the usual Elmendorf tear-tester.

A strip of paper is clamped between two clamps, one of which is fixed and the second attached to a pendulum. At the beginning of the measurement the two clamps are parallel and close to each other, and the pendulum is held in place by a spring-type release. The paper, which always has the same width, is clamped in place and a cut of a fixed length is made in it, in order to facilitate the beginning of the tear; when the release is operated and the pendulum swings, pushing with it a pointer having the same axis as the pendulum but having a certain friction with that axis. The friction is adjusted in such a way that the pointer is pushed to the farthest point to which the pendulum reaches, but does not return. In this way the pointer remains at a point corresponding to the highest point reached by the pendulum, and by a suitable calibration the energy dissipated in tearing the paper strip can be calculated.

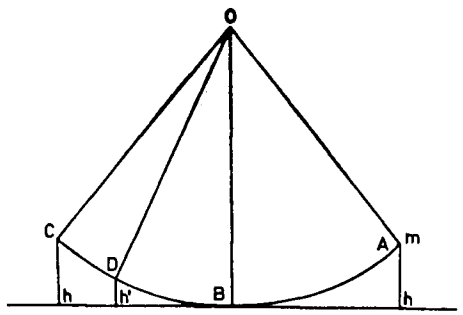


FIG. 2.
An ideal pendulum – to explain the computation of energy dissipation.

Let us consider the principle involved in the pendulum type instrument. A mathematical pendulum (Fig. 2) (i.e.: a mass m hanging on a weightless arm fixed on a friction-free axis o) if moved to a point A at a height h from equilibrium position B, acquires a potential energy of mgh relative to the equilibrium. When the mass is released the pendulum begins to move until it reaches the point C which will again be at the height h, due to the law of the conservation of energy. If a certain amount of energy is dissipated in the movement (by friction, or by tearing of paper) the pendulum will reach a point D which will be at a smaller height h'. As the initial energy was mgh and the final is mgh' the energy dissipated is: $mgh - mgh' = mg(h - h')$. Thus, the dissipation of energy is directly proportional to the difference between the initial and final height of the pendulum.

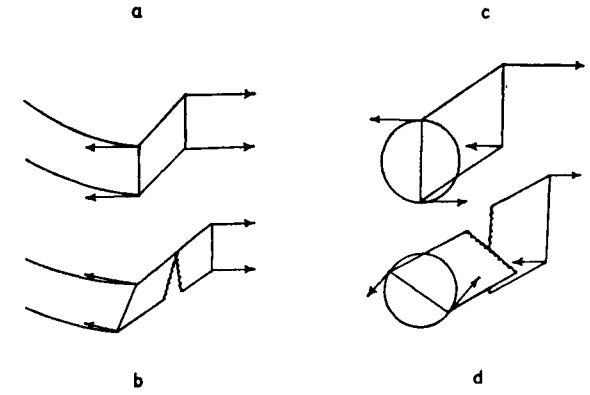
Thus a tear instrument constructed so that friction is negligible compared with the force needed to tear the paper can be easily calibrated.

CONSTRUCTION OF THE SIMPLE INSTRUMENT

A pendulum-type tear tester is obviously one of the simplest possible instruments and therefore it is one of the first I attempted to construct. The following modifications were made in the Elmendorf instrument in efforts to achieve maximum simplicity:

a) Placing of the clamps

Instead of placing the clamps somewhere along the arm of the pendulum, they were placed at the axis of the pendulum. This was not only because of constructional problems, but also because in this way the tearing motion is more similar to tearing by hand (Fig. 3). It has the additional advantage that the forces involved are smaller, and thus a more accurate release mechanism (such as an electromagnetic release) is possible.



a Elmendorf at beginning of tear
b Elmendorf at end of tear
c Modified instrument at beginning of tear
d Modified instrument at end of tear

FIG. 3. The difference in tearing of paper by the Elmendorf and the modified instrument. The Elmendorf tears the strip while it is moving along an arc far from the axis; in the modified instrument the axis of rotation is in the middle of the tear-line on the strip (c, d).

b) Substitution of the pointer with a recording pen

Instead of the friction pointer, a pen (or a pencil) was introduced. This has the following advantages: it is simpler to construct (see details in Fig. 4) and the results are recorded on simple millimetric paper. In addition, the recording system is more convenient, as it is possible to translate the results into numbers

after a series of measurements was completed, and thus the possibility of errors in writing down results is diminished. Furthermore it is possible to recheck results from the paper after some time.

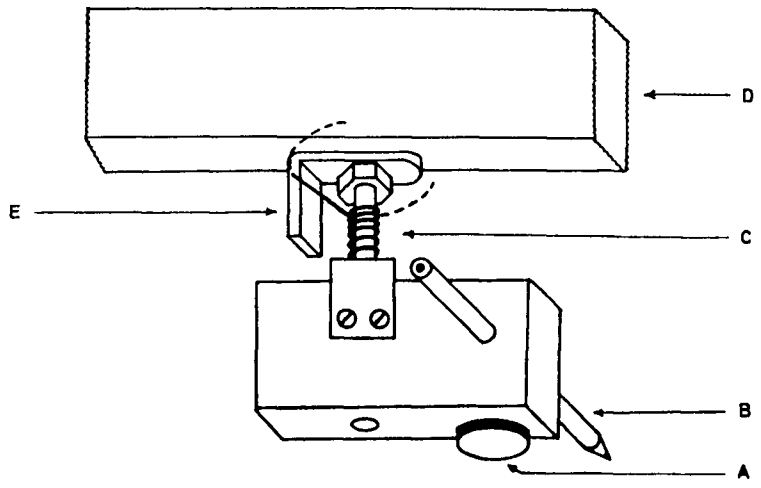


FIG. 4. The pen which substitutes the friction pointer.

A Pen clamp B Pen C Spring pushes the pen to the chart
D Pendulum E By moving the catch along the dotted line the pressure of the spring may be adjusted

c) Release mechanism

Although the simplest release mechanism (Fig. 5) suffices for most measurements, better repeatability might be achieved by using a simple electromagnet as a release (Fig. 6, Table 1).

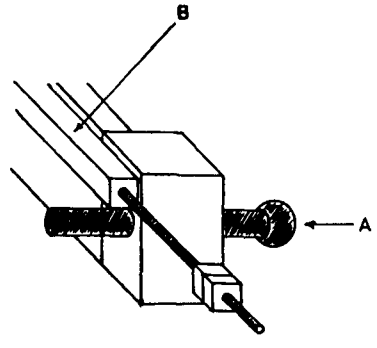
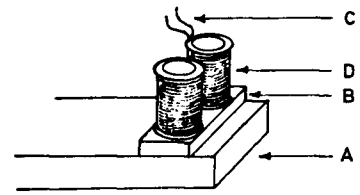


FIG. 5.
Hand-release of the pendulum.

A Release
B Pendulum

FIG. 6.
The electromagnetic release



A Pendulum
B Iron (attached to the pendulum)
C To switch (12 V.)
D Electromagnet

TABLE 1: Repeatability of hand and electromagnetic release at »no load«
(See explanations of factors in Table 2)

Reading no.	Electro magnetic	d	d^2	Hand	d	d^2
1	67	— 1.4	1.96	68	+ 1.7	2.49
2	68	— 0.4	0.16	66	— 0.3	0.09
3	68	— 0.4	0.16	66	— 0.3	0.09
4	69	+ 0.6	0.36	65	— 1.3	1.69
5	69	+ 0.6	0.36	66	— 0.3	0.09
6	69	+ 0.6	0.36	68	+ 1.7	2.49
7	69	+ 0.6	0.36	67	— 0.7	0.49
8	68	— 0.4	0.16	65	— 1.3	1.69
9	69	+ 0.6	0.36	66	— 0.3	0.09
10	68	— 0.4	0.16	66	— 0.3	0.09
	68.4	—	—	66.3	—	—
M	0.60			0.82		
A	2			3		
σ	0.67			1.02		
CV%	0.98			1.52		

The construction of the instrument is simple enough as can be easily seen from Fig. 7.

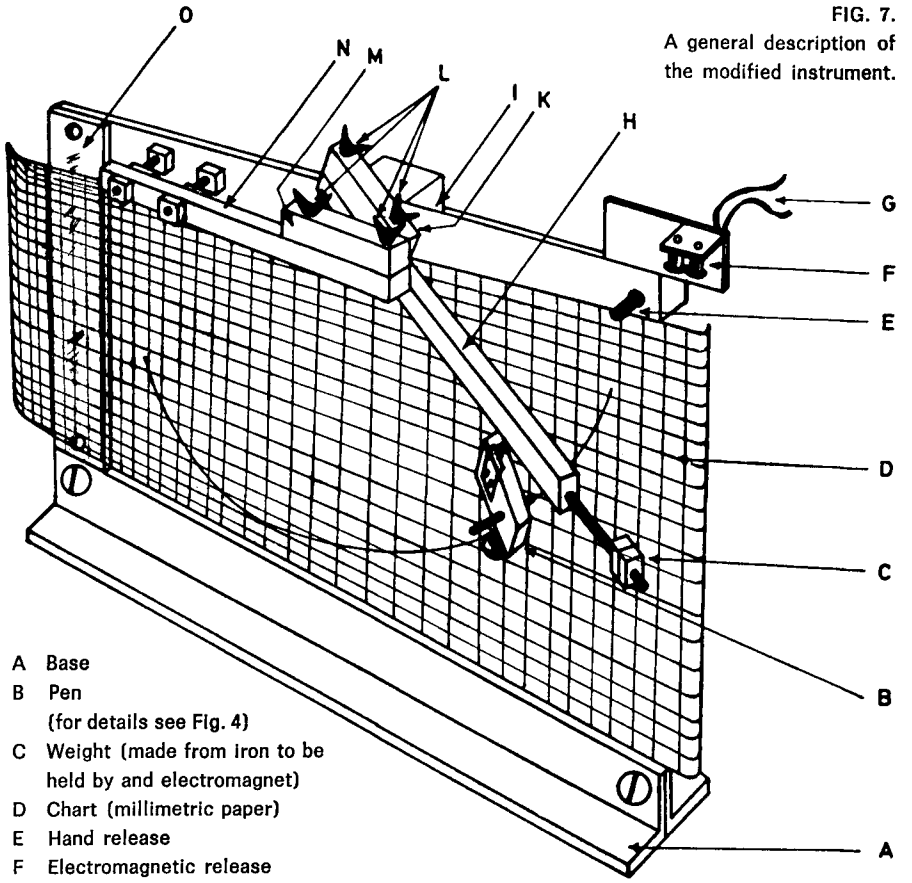


FIG. 7.
A general description of the modified instrument.

A Base
B Pen
(for details see Fig. 4)
C Weight (made from iron to be held by and electromagnet)
D Chart (millimetric paper)
E Hand release
F Electromagnetic release
G To current (12 V.)
H Pendulum I Bearing house (brass) K Moving clamp L Winged nuts
M Fixed clamp N Fixed clamp arm O Plastic rule (to hold chart in place)

Interpretation of Results

The results on the millimetric paper (Fig. 8) are in millimeters of difference of height. Because of various forces (friction between the pencil and the chart, friction at the axis of pendulum, etc.) the pendulum does not swing to its original height, but to a lower »no load« height h. When a strip of paper is clamped and torn, the pendulum reaches a height of h_p only. The heights are measured from the lowest point described by the pen on the paper.

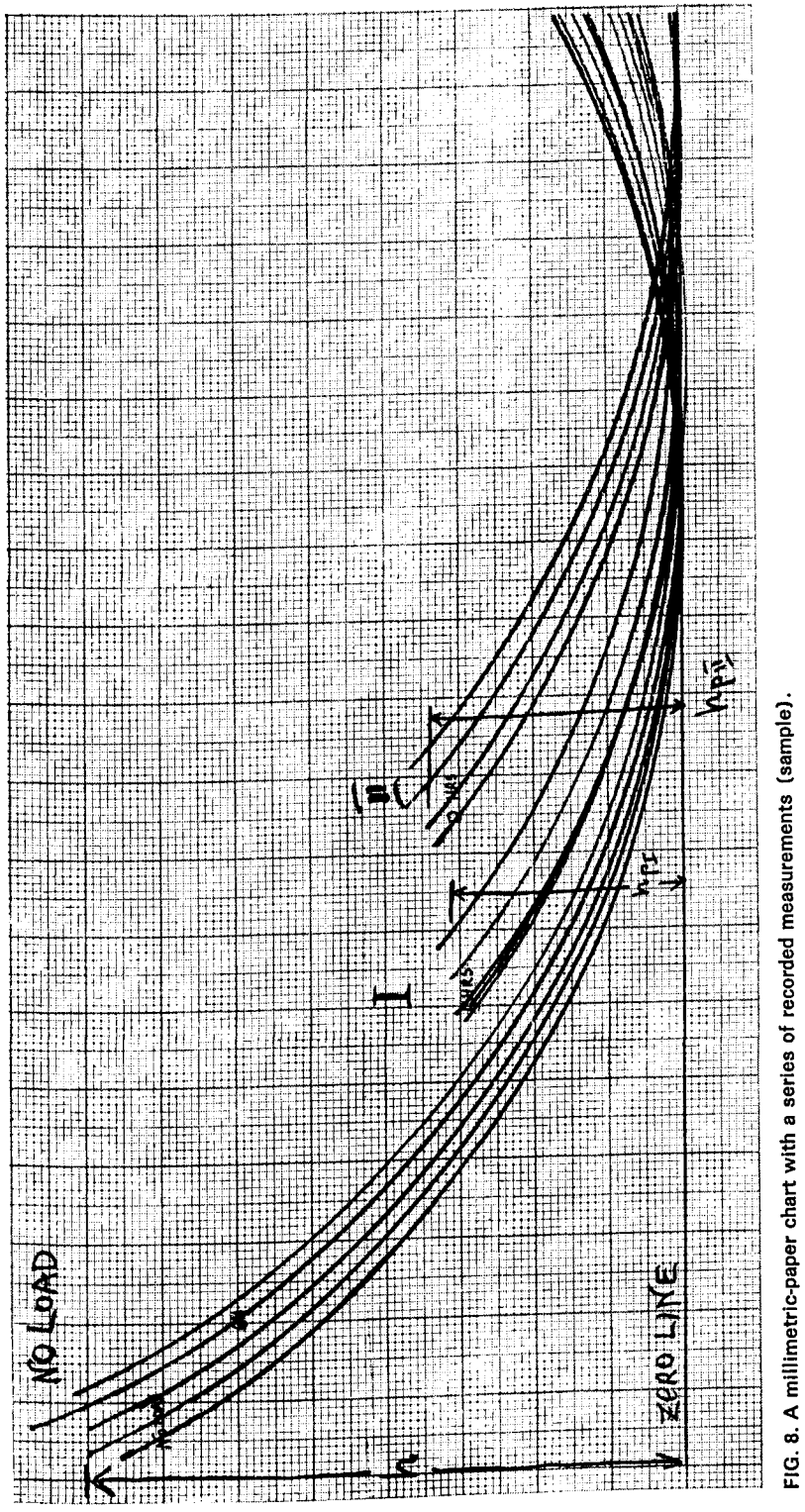


FIG. 8. A millimetric-paper chart with a series of recorded measurements (sample).

By attaching a fine spring balance to the point where the pen is attached to the pendulum, the weight w at that point may be measured and the pendulum may be regarded as a mathematical pendulum with the mass m where $w=mg$. (This was in fact done and the pendulum constructed is equivalent to 50 gr suspended at 14 cm from axis). The friction may be disregarded because of the following (assuming that the friction is constant):

1. The energy dissipated when no paper is clamped, when the initial height is h_i and the final »no load« height is h is: $w\ (h_i - h)$. This is the energy dissipated because of friction.
2. With paper clamped in it is: $w\ (h_i - h_p)$
3. The difference is:
   $w\ (h_i - h_p) - w\ (h_i - h) = w\ (h_i - h_p - h_i + h) = w(h - h_p)$

For relative measurements, defining a paper which dissipates exactly all the potential energy to have a strength of 100 %, we may define the *relative strength* E_R by:

$$E_R = \frac{w\ (h - h_p)}{w\ (h)} = \frac{h - h_p}{h} \quad \text{or: } E_R\% = \frac{h - h_p}{h} \times 100$$

This depends of course on the weight and length of the pendulum but is quite sufficient and convenient as long as the instrument remains unchanged.

Procedure

a. The paper to be tested is cut into strips 2 cm wide. *No initial tear is made.*
b. The pendulum is released at least 6 (preferably 10) times without paper to determine h.
c. The strips are clamped one after the other and the pendulum is released.

Care should be taken to move the millimetric paper at least 2 mm to the left before each new reading is made (so that the arcs drawn are separated). At least 6 (preferably 10) readings should be made.

A series of tests with various papers indicates satisfactory repeatability and reasonable sensitivity of the instrument. I have chosen two examples to illustrate this:

a. Aging of newsprint

A page of newsprint was divided into two parts, one was kept as a control and the other was aged at 100° C for 5 hours, and reconditioned to room environment for 24 hours. The results are given in Table 2.

Table 2: Aging of newsprint

Reading no.	No load h_{mm}	d	d^2	Unaged h_{mm}	d	d^2	Aged 5 hrs h_{mm}	d	d^2
1	66	— 2.2	4.85	29	— 4.9	24.0	50	+ 0.9	0.81
2	67	— 1.2	1.44	31	— 2.9	8.4	51	+ 1.9	3.60
3	68	— 0.2	0.04	35	+ 1.1	1.21	50	+ 0.9	0.81
4	68	— 0.2	0.04	33	— 0.9	0.81	46	— 3.1	9.55
5	69	+ 0.8	0.64	33	— 0.9	0.81	47	— 2.1	4.40
6	69	+ 0.8	0.64	36	+ 2.1	4.4	49	— 0.1	0.01
7	69	+ 0.8	0.64	35	+ 1.1	1.21	50	+ 0.9	0.81
8	69	+ 0.8	0.64	38	+ 4.1	16.8	48	— 1.1	1.21
9	68	— 0.2	0.04	35	+ 1.1	1.21	52	+ 2.9	8.40
10	69	+ 0.8	0.64	34	+ 0.1	0.01	48	— 1.1	1.21
$\overline{X}$	68.20			33.90			49.10		
M	0.80			1.91			1.50		
σ	1.03			2.56			1.85		
VC%	1.52			7.56			3.78		
A	3			7			6		
$E_R\%$	0 %			50.5 %			28.0 %		

n = Total number of readings
X_i = Value of a single reading
$\overline{X}$ = Mean
d = Deviation = $X_i - \overline{X}$
M = Mean deviation = $\dfrac{\sum_{i=1}^{n} (X_i - \overline{X})}{n}$
σ = Standard deviation = $\left(\dfrac{\sum_{i=1}^{n} (\overline{X} - X_i)^2}{n-1}\right)^{\frac{1}{2}}$
VC% = Variation coefficient = $\dfrac{\sigma}{\overline{X}} \times 100$
A = Amplitude = difference between lowest and highest reading
$E_R\%$ = $\dfrac{h - h_p}{h} \times 100$

b. Sensitivity to machine and cross direction

6 strips were torn from the machine direction and 6 from the cross direction of the same page of newsprint. Results are given in Table 3.

TABLE 3: Direction and strength

Reading no.	No load h_{mm}	Machine h_{mm}	Cross h_{mm}
1	62	43	28
2	63	39	29
3	64	42	26
4	63	42	26
5	65	42	28
6	65	43	23
$\bar{X}$	63.7	41.8	26.7
$E_R\%$	0%	66%	42%

An overall relative strength may be defined by:

$$E_{RO}\% = \left(\frac{E^2_{R\ machine} + E^2_{R\ cross}}{2}\right)^{\frac{1}{2}}$$

»Fibre strength« may be defined as:

$$E_{Rf}\% = \frac{E_{Rmachine} - E_{Rcross}}{E_{Rmachine}} \times 100$$

In our case:

$$E_{RO}\% = 55.4\% \qquad E_{Rf}\% = 36.4\%$$

CONCLUSION

The instrument may be easily constructed in any workshop and has sufficient sensitivity and repeatability.

ABSTRACTS

A description is given of a simple instrument for measurement of tear resistance, which can be made by any small workshop. The instrument is a modification of the Elmendorf tear tester and the following changes were introduced:

a) The paper is clamped at the axis of the pendulum instead of along its arm.

b) The friction pointer was replaced by a recording pen and a chart, giving both the advantages of simple construction and of recorded results.

c) An electromagnet has been introduced instead of the spring release.

For relative measurements and for a given instrument a paper having a strength of 100 % is defined as that needing exactly all the potential energy of the pendulum to be dissipated in its tearing. Thus the relative strength of the paper is defined by: $E_R\% = \frac{h - h_p}{h} \times 100$ where h is the height the pendulum reaches without tearing any paper (i.e. when it is free), and h_p the height it reaches when it tears paper. Terming the strength $E_{Rm}\%$ when the tear is in the machine direction and $E_{Rc}\%$ when the tear is in the cross direction of the paper, then we may define:

$$\text{Overall strength: } E_{RO}\% = \left(\frac{E^2_{Rm} + E^2_{Rc}}{2}\right)^{\frac{1}{2}}$$

$$\text{Fibre strength: } E_{Rf}\% = \frac{E_{Rm} - E_{Rc}}{E_{Rm}} \times 100$$

The instrument shows satisfactory repeatability and sensitivity.

Описывается простой прибор для измерения сопротивления разрыву, который может быть изготовлен в любой небольшой мастерской. Прибор является видоизменением прибора Элмендорфа, служащего для испытаний на разрыв, и отличается следующим:

а) бумага защемляется у оси маятника, а не вдоль его плеча;
б) фрикционный указатель заменен регистрирующим пером и графиком, что, наряду с простотой конструкции, дает преимущество записи результатов;
в) пружинное спускное приспособление заменено электромагнитом.

При относительных измерениях на данном инструменте прочность бумаги принимается как 100%, если требуется диссипация всей потенциальной энергии маятника для разрыва бумаги. Таким образом, относительная прочность бумаги определяется как $E_R\,\% = \frac{h - h_p}{h} \times 100$, где h — высота, достигаемая маятником при отсутствии бумаги, а h_p — высота достигаемая им при разрыве бумаги. Обозначая прочность $E_{Rm}\%$ при разрыве в направлении прибора, и $E_{Rc}\%$ при разрыве поперек бумаги, мы можем определить искомую прочность:

$$E_{RO}\,\% = \left(\frac{E^2_{Rm} + E^2_{Rc}}{2}\right)^{\frac{1}{2}}$$

$$E_{Rf}\,\% = \frac{E_{Rm} - E_{Rc}}{E_{Rm}} \times 100$$

Прибор обладает достаточной чувствительностью и повторимостью результатов.

Рис. 1. Схематическое изображение обычного прибора Элмендорфа для испытания на разрыв.
Рис. 2. Идеальный маятник, для пояснение расчета диссипации энергии.
Рис. 3. Отличие в разрыве бумаги прибором Элмендорфа и видоизмененным прибором. Прибор Элмендорфа разрывает полосу при ее движении по отдаленной от оси дуге окружности; в видоизмененном приборе ось вращения в середине линии разрыва полосы (c, d).
Рис. 4. Перо заменяющее фрикционный указатель.
Рис. 5. Ручной спуск маятника.
Рис. 6. Электромагнитный спуск.
Рис. 7. Общий вид видоизменного прибора.
Рис. 8. Миллиметровая бумага – график с рядом занесенных измерений (образец).

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25 лет научно-производственной деятельности Юлии Петровны Нюкша Заведующей Отделом гигиены и реставрации книг Государственной публичной библиотеки им. М. Е. Салтыкова-Щедрина (г. Ленинград)

Л. С. СЕМЁНОВА

В Государственной публичной библиотеке имени М. Е. Салтыкова-Щедрина с 1936 г. существует группа гигиены и реставрации, в 1948 г. по решению Министерства культуры РСФСР организована самостоятельная лаборатория, а в 1950 г. на их основе создан Отдел гигиены и реставрации. С момента образования Отдела постепенно сформировались три основных направления его деятельности, которые в настоящее время выражаются в следующем: 1) ведение разнохарактерных научных исследований, составляющих основу всей практической деятельности по сохранности фондов; 2) выполнение работ по сохранности фондов, для которых обязательно использование специальных материалов, приборов, оборудования и необходима определенная квалификационная подготовка работников; 3) научно-методическая и консультационная работа.

С 1956 г. Отделом гигиены и реставрации книг в Государственной публичной библиотеке руководит кандидлт билогических наук, старший научный сотрудник Юлия Петровна Нюкша. Вся ее научно-практическая деятельность, 25-летний юбилей которой отмечался научной общественностью в октябре 1969 г., тесно связана с развитием науки и практики консервации и реставрации научных и культурных ценностей.

Юлия Петровна после окончания в 1944 г. Ленинградского Государ-

ственного Университета имени А. А. Жданова была направлена в Государственную публичную библиотеку для прохождения аспирантуры по специальности гигиены и реставрации книг, которую успешно закончила защитой диссертации на тему: «Грибы на книгах и их роль в разрушении книжных материалов». В настоящее время она ведущий специалист страны по сохранности библиотечных фондов, автор более 50 опубликонных научных работ, широко известных в СССР и за рубежом*).

Направление исследований Ю. П. Нюкша, ее научные интересы определялись задачами, стоящими перед библиотеками и другими хранилищами страны и направлялись достижениями науки вообще и биологии, химии, техники в частности. Основные изыскания Юлии Петровны связаны с изучением процессов микробиального и физико-химического разрушения книги и бумаги, изысканием средств их защиты, долговечности, грибоустойчивости и дезинфекции различных материалов.

Исследования Ю. П. Нюкша по микробиальному поражению бумаги-печатных изданий, рукописей, начатые ею много лет назад и разрешившие целый ряд важных вопросов, успешно развиваются ею и в настоящее время, затрагивая все новые аспекты.

Впервые Юлией Петровной было осуществлено обобщение собственных и литературных данных о систематике грибор, вызывающих порчу пниг, бумаги и бумажной массы. Список вредителей этих материалов к началу 60-х годов уже насчитывал более 260 видов. Особого внимания заслуживают оригинальные работы по пигментапии различных видов бумаги грибами, ее поражаести и изменению этих качеств в связи с введением в библиотечную практику новых синтетических материалов. Эти исследования, посвященные казалось бы сцециальным вопросам, вместе с тем вносят новые оригиналные сведения в раздел физиологии грибов. Значительные исследования проведены также по защите материалов от биологического повреждения, в частности обобщены данные, относящиеся к химическим средствам предохранения фондов. Составленная Ю. П. Нюкша сводка по фунгицидам содержит их подробную характеристику и рекомендации полезные всем тем, кто нуждается в применении их для защиты библиотечных материалов. В упомянутом труде обращает внимание оригинальный подход одновременного повышения долговечности и грибоустойчивости бумаги путем введения химических веществ в массу.

Осмысление процессов, происходящих в хранении и использовании

*) См. список научных трудов.

фондов, и собственные углубленные исследования, примененные к условиям ускоренного роста книжных фондов библиотек, появления новых видов бумаги, привели Ю. П. Нюкша к формулировке и раскрытию принципа дифференцированного подхода к консервации и реставрации библиотечных материалов. Этот принцип выдвинут как антитеза несостоятельному в наше время универсализму. Многолетний поиск и детализация сделали неотъемлемым принцип строгой выборочности при решении всех вопросов, связанных с реставрацией любого материала. Теперь принцип дифференцированного подхода получил широкое практическое применение и является научной основой не только для библиотек, но и для всех учреждений, занятых консервацией и реставрацией. В настоящее время Отдел гигиены и реставрации Государственной публичной библиотеки имени М. Е. Салтыкова-Щедрина, руководимый Ю. П. Нюкша, является известным научно-исследовательским центром, из стен которого выходят ценные исследования. Его производственные группы оснащены современной техникой и пользуются передовыми методами работы. Используя достижения науки, сотрудники Отдела умело выбирают необходимый комплекс материалов и воздействий для каждого случая восстановления материала. В практику введены способы стабилизации бумаги и повышения ее сопротивляемости старению. С помощью синтетических покрытий печатные издания получают прочность, необходимую им при интенсивном читательском использовании.

С середины 50-х годов по инициативе Ю. П. Нюкша Отдел начал последовательную технизацию производственных процессов. В 1956 г. при ее непосредственном у частии была создана новая вакуумная камера для дезинфекции книг. В эти же годы ею были заложены научные основы методов ламирования и разработан новый метод реставрации при помощи долива утраченных участков листов из бумажной массы. В эти годы была создана лабораторная аппаратура для подготовки массы и отлива недостающей частей бумаги, которая на протяжении 10 лет находилась в непрерывном производственном использовании. Преимущества нового метода реставрации при помощи бумажной массы были высоко оценены всеми без исключения реставраторами. При этом подчеркивалось, что такой способ работы позволяет избежать применения огромных количеств клея, который не способствует долговечности материалов.

Дальнейшее совершенствование метода и накопленный практический опыт позволили приступить в 1964 г. к созданию новой совершенной аппаратуры, позволяющей делать отливки на большой площади и без

применения клеевых составов. Управление аппаратурой, подача массы в форму и некоторые другие операции механизированы. Аппаратура снабжена прессом оригинальной конструкции и сушильными установками.

Проведз соответствующую исследовательскую работу Отдел освоил способы реставрации при помощи ламинирования и импрегнирования. В 1962 г. после тщательных изысканий была создана дублированная пленка для двухстороннего наслоения на бумагу при помощи двухвальной машины. В 1964 г. для запресовки каталожных карточек и разделителей был введен ручной винтовой пресс, сконструированный в Отделе. С 1968 г. осуществляется запресовка в синтетические пленки карт, газет и других материалов.

Начиная с 1944 г. при участии Ю. П. Нюкша в Библиотеке организована и совершенствуется система предохранения фондов от разрушения, выработаны нормы и правила их консервации, установлен и неукоснительно проводится в жизнь контроль за режимом и профилактикой хранения библиотечных ценностей.

Ю. П. Нюкша ежегодно оказывает научную и методическую помощь десяткам библиотек, музеев и архивов страны по широкому кругу вопросов, связанных с режимом хранения, дезинфекцией, обработкой материалов, общими и частными вопросами консервации и реставрации, по микробиологическому и физико-химическому старению бумаги и предотвращению этих явлений, грибоустойчивости, по приданию долговечности различным материалам, составляющим основу научных и культурных ценностей.

Отдел имеет широкие связи с научными учреждениями, и многие видные ученые принимают участие в решении конкретных воцросов его работы.

Принципиальные теоретические и методологические вопросы консервации и реставрации, их оценка с позиций современной науки, конкретное претворение в жизнь, а также определение перспектив развития Отдела и его внутренней организации и места в кругу аналогичных учреждений тщательно обсуждаются на Научно-шетодических советах Отдела под под председательством Ю. П. Нюкша.

Юлия Петровна является не только авторитетным ученым и высоко квалифицированным специалистом в области гигиены и реставрации книг., но и превосходным организатором. Работа, руководимого ею Отдела, включает большой комплекс разнохарактерных вопросов сохранности фондов, которые успешно решаются на уровне современных научных знаний.

Высокую оценку научно-производственной деятельности Юлии Петровны Нюкша дали в своих выступлениях присутствующие на ее юбилее пробессора Ленинградского университета З. Г. Разумовская, В. Я. Частухин, профессора М. К. Хохряков и Д. М. Фляте, директор ЛКРД АН СССР М. Ф. Мурьянов, заведующая реставрации графики Государственного Эрмитажа А. М. Аносова, заведующий реставрационными мастерскими Государственного Русского музея А. Б. Бриндаров и многие другие. Кроме того в адрес юбиляра были получены поздравительные телеграммы из многих библиотек и центров по реставрации и консервации научных и культурных ценностей страны, в том числе от коллектива кафедры низших растений ЛГУ, от сотрудников Всесоюзной Государственной Библиотеки Иностранной литературы, коллективов Государственной Исторической библиотеки, Государственной библиотеки Эстонии им. Крейцвальда и библиотеки Тартуского Университета, коллективов Государственных центральных художественных научно-реставрационных мастерских, сотрудников Всесоюзного научно-исследовательского института документоведения и архивного дела, коллектива отдела реставрации Института марксизма-ленинизма при ЦК КПСС, от докторов биологических наук Ботанического института АН СССР М. А. Литвинова и Н. С. Новотельновой и др.

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Problems of resistance to fungi in books and documents.

SUMMARY: The 25th Anniversary of the Commencement of the Scientific Activity of Yu. P. Nyuksha.

In October 1969, the scientists of the USSR celebrated the twenty-fifth anniversary of Yulia Petrovna Nyuksha's scientific activities. She is a prominent scientist in the biological sciences, and Head of the Department of Hygiene and Restoration of Books in the M. E. Saltykova-Shchedrin State Public Library of Leningrad.

Yu. P. Nyuksha is a leading specialist in the field of conservation and restoration of library materials. Her research work has been concentrated on processes of microbial, physical and chemical destruction of books and paper, for which she has developped methods of protection. The results of her achievements have been published in more than 50 scientific publications. Among her achievements may be mentioned a new vacuum chamber for the disinfection of books, the elaboration of a new method for the restoration of damaged pieces of paper by the addition of paper pulp, and the achievement of a differentiated approach to the conservation and restoration of library materials. Under her guidance, the Department of Hygiene and Restoration of Books have been established as a well-known center, whose subdivisions are provided with the most up-to-date equipment, and whose research methods are considered to be very progressive.

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Hygiene and Restoration of Book Stock at Libraries

Some Points of Interest Regarding the Work of the Lenin State Library of the USSR

by GALINA S. ROZKOVA

Invaluable treasures, such as manuscripts and printed books are stored in libraries, and it is a duty of great importance and much responsibility to preserve these most precious cultural monuments of the past and the present for future generations. As is well known, the main materials used for books are paper, printing ink, glue, cardboard, leatherine, calico, leather, etc., all of them substances of organic origin. When kept for a long time, all organic substances undergo a number of physical and chemical transformations which constitute the process of natural ageing. This process may develop faster or slower depending on the storage conditions. Therefore the ensurance of a long-term preservation of book collections is one of the primary tasks of the Moscow V. I. Lenin State Library of the USSR, the book stock of which runs into more than 25 million volumes.

In 1944 a Department of Book Hygiene and Restoration was opened at the Library. Until this time there was only a group of experts who dealt with the problems of book stock preservation. The principal task of the Department is the preservation of the book stock, research work in the field of book preservation and methodological assistance to other libraries and public institutions in the country.

Structure of the Department

1. Section of Book Hygiene and Disinfection
2. Section of Book Restoration
3. Research Laboratory

1. Section of Book Hygiene and Disinfection

The Hygiene and Disinfection Section is responsible for scanning the book stock, page-by-page and general dusting, disinfection and fumigation of book and premises, and also for temperature and humidity control in the depositories.

Every year the Library expands its stock with all new items published in the Soviet Union and also any literature of the previous years which is not found in stock. Foreign literature is also regularly received from abroad. In addition private persons often contribute their collections or individual books to the Library. All the in-going books are carefully examined by the scientific workers of the Hygiene Section to reveal »sick« or soiled books (dust, foreign bodies, ozokerite, etc.). Only after a thorough examination is a book accepted for storage.

When a coating of mould fungi or pest damage is detected, the book is first sent to the Hygiene Section for disinfection and paginal clean-up.

The paginal clean-up is carried out in the following way: each page is wiped with a wad of cotton wool moistened with a 2–3 % formaldehyde solution. Dust, litter and foreign bodies (remnants of flowers, leaves, hairs, etc.) are removed from the pages and the spine by means of a special brush.

The mould coating is removed with a wad of cotton wool so as not to spread it further over the page. If necessary, the book undergoes disinfection in a vacuum steam formaldehyde camera.

Insects are a great danger to books, which can be damaged by different varieties. However, death watch beetles, larder and black carpet beetles, silver fish, carpet and clothes moths, and cockchafers are particularly dangerous. If book pests are observed, 2–3 drops of a fumigant or a 2 % chlorophos solution are introduced into the spine through the top and bottom opening. The book is then wrapped in paper for 24 hours. In order to remove pest-made meal, excrement, larva scales, or dead insects, the book is subjected to a paginal clean-up. After having undergone the paginal clean-up, disinfection, or fumigation, the »sick« book is accepted for storage.

The book stock of the Library is regularly checked by the scientific workers of the Hygiene Section. Every year, in spring and autumn, the books are sample-surveyed for timely pathological detection. Books stocked on lower shelvings, near outer walls, windows, and corner shelvings are sample surveyed as these are most liable to damage from mould under the

increased air humidity. Crumpled books or books with signs of damp are particularly minutely examined as mould usually develops inside these. Ancient books on rag paper are also carefully examined, because mould appears on these far more frequently than on other papers.

Mould fungi resemble velvety, coloured coatings or fox marks of various colourations on the binding and the leaves of a book. The embryonic layer of fungus colonies appears as a whitish and very mild coating. In the latter case, the book's spine must be examined much more attentively so as to observe any signs of damage. During such a scrupulous examination insects may be noticed which multiply rapidly with the approach of spring and may seriously damage the book. Besides the sample survey, a close scanning of the whole book stock is carried out every year by the Hygiene Sections' experts to reveal »sick« books. During the close scanning every single book is taken off the shelf. The outer side of the binding and the edges are examined first, then the inner side of the binding, the spine line, the fly leaf, and the title page. These are the parts of a book which most often suffer from mould and insects. The inner leaves are less thoroughly investigated, but special attention is paid to places of former pastings.

Every »sick« book in need of treatment is specially marked and sent to the Hygiene Section for a paginal clean-up, disinfection or fumigation.

Disinfection and fumigation are carried out in a vacuum disinfection camera, whereas the paginal clean-up is performed in an extraction hood. After the paginal clean-up, the book is laid out in a V-position for drying and formalin evaporation. Alcoholic thymol is used for the paginal clean-up of books in leather bindings.

At the Library we pay great attention to the hygienic treatment of the book stock. Stock must be dusted at least twice a year. For this operation we use the conventional »Uralets« and »Moskva« vacuum cleaners. Some libraries have special dust-cleaning machines.

The conditions of storage are of vital importance to the preservation of book treasures. A strict observation of normal temperature and humidity rules guarantees a long-term preservation of books in good shape. We consider it advisable to keep books in premises at a temperature of 16–18° C. and an air humidity of 55–60 %.

In the Lenin State Library of the USSR climatic measurements are made every day in 84 different locations. We use the conventional psychrometers (a hygrometer consisting essentially of two similar thermometers with the bulb of one kept wet so that the resulting cooling from evaporation makes it register a lower temperature than the dry one); the difference between the

readings then gives a measure of air humidity. The Assmann aspiration psychrometer is used in order to check the psychrometer readings.

2. Section of Book Restoration

Even though all the required conditions are observed a mishap may occur, and a book may have to undergo restoration. A timely restoration can remarkably prolong the service life of books, newspapers, magazines, and other materials.

At the Lenin State Library the complete process of restoration is carried out on the spot by the experts of the Restoration Section. There are no universal restoration methods and therefore in each case the restorer has to find the best way of restoring the damaged material by applying exclusively checked and scientifically based methods. Our restorers make use of the classical methods. No mechanized methods (as paper pulp filling, lamination, etc.) are at present being used at our Library, but we find the method of filling the worn parts of a leaf with paper pulp to be very efficient, and feel that it should be widely applicated. In the near future we hope to acquire and put into use a paper-filling machine. In Bulgaria they have designed a new time-saving and highly effective paper-filling machine of particular interest.[1]

Before starting to restore an item, the restorer must be supplied with all the necessary tools and materials. The restorer's working place is equipped with a special table having a light underneath, a set of instruments and materials. The basic materials used for paper restoration are glue and various sorts of paper which are used to fill the worn-out leaf matter and strengthen decrepit leaves. The glue must not destroy the material. It must form a transparent film, be convertible and of a high adhesive capacity. Ordinary glues cannot be used for restoration as they destroy the paper. At the Library we use a glue made according to a special recipe from highest quality wheat flour. Antiseptics are added to make it vermin proof.

3. Research Laboratory

All the methods applied by our restores are first investigated and tested at the Research Laboratory by experts – chemists and biologists (mycologists and entomologists). The Chemical Section conducts research on paper,

leather, parchment, and other materials for conservation and restoration by applying different means and methods based on various chemical substances. The Mycology Section studies air mycoflora in book storage premises, selects antiseptics for the flour adhesive and disinfectants for the paginal clean-up and camera disinfection, and also deals with mould fungi control. The Entomology Section studies book pest bioecology and selects insecticides for insect control.

Using methods developed by the specialists of the Laboratory, the restorers have renewed a great number of manuscripts, and rare and precious books. The Manuscript Department often receives manuscript material from private persons or from experts who make expeditions in search of such materials. More often than not the materials are seriously damaged due to unfavourable storage conditions and are in need of immediate restoration. For instance, the Library received a XVI century book with its outer appearance as shown in I. K. Belaya's article on parchment softening in this journal[2] (Fig. 1). After restoration (Fig. 2) the book can well be used for investigation purposes.

Many writers wrote their manuscripts in pencil (black graphite), and on other works there are pencil-made marks. All the pencil-written texts have now been strengthened with carboxymethyl or methyl cellulose solution, their existence being thus remarkably prolonged.

Also stored at the Library are posters printed with glue colours which eventually fall off. In the process of restoring the colour layer of the posters is strengthened, while the poster itself is duplicated onto a mica paper. The duplication is carried out by means of organic glass which accounts for the glossy surface of the reverse side of the poster. When folded, the poster does not tear along the folded edge.

We are much occupied with problems concerning the softening of leather bindings of old books and manuscripts. It is no secret that during long-term storage leather suffers extensive chemical and physical changes leading to its destruction. These changes in the leather depend on the type of tanning, the method of treatment, and the storage.

The visible signs of ageing are brittleness, fragility and deformation. Eventually old leather loses its adipose matter which must be regularly reintroduced in the required quantities. Natural fat and oil should be used for this purpose as they are not oxidized by the oxygen of the atmosphere. Mineral oil and turpentine lubricants in particular are ruious for leather.

At the Library we use a special leather softening lubricant suggested by I. K. Belaya. The method is described and the ingredients of the lubricant

are given in this journal.[3] Apart from adipose introduction we also restore leather bindings. The worn-out matter of the binding is filled with leather made according to the red oak tanning method without the cover painting. PFE 2/10 methyl polyamide is used as a glue when restoring leather binding.

The storage of newspapers meets with serious difficulties in all libraries as they are printed on low quality paper which very soon turns yellow, crumbles and becomes brittle.

At present when restoring newspapers we fill the worn-out matter with newsprint and strengthen the sheet edges with mica paper and the text foldings with condensing paper.

Of some interest is the method of Hungarian restorers, who use laminator and Japanese silk paper instead of films for newspaper restoration. Undoubtly, the mechanization of newspaper restoration and preservation is of great value.

Restorers of different countries have much in common, but at the same time there are many differences. First with regards to the conditions of book storage. Under best conditions one finds air conditioning, constant temperature and humidity, hermetic windows made from a light dispersing glass, and mechanized dusting. However, no matter how excellent the storage conditions are, the process of natural ageing continues. Therefore it is imperative that library premises should be built or reconstructed with due regard to the provision of sufficient space for the department (section) of hygiene and restoration with the necessary equipment.

In September 1968, the III International Conference on Library Building, Equipment and Mechanization was held in Bulgaria. S. Alkalaj (Bulgaria), L. Skřivánek (Czechoslovakia), D. Gawrecki (Czechoslovakia) and G. Müller (German Democratic Republic) delivered a paper on »Conseptions and Up-to-date Problems of Preventive Protection, Restoration and Preservation of Books Collections«. The report dealt with the fundamentals of book preservation, book depository equipment, hygiene, and the chief methods of restoration: classical, lamination and the method of splitting the paper sheet and filling the worn-out matter with paper pulp by means of a paper-filling machine. In addition were provided a list of the necessary equipment and a plan of premises with regard to book stock hygiene.

We feel certain that the discussion of common problems at similar conferences and a wider publication of restoration experience from a number of countries would contribute greatly to the cause of restoration and preservation of those most precious book collections now owned by libraries.

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Some Observations of the Development and Nutrition of Booklice

by Z. P. BARYSHNIKOVA

With the exception of a few species Psocoptera live in woods, in parks and in gardens on trees and busches, where there is a relatively high degree of air humidity. They live of fragments of animal or vegetable matter, particularly on microscopic mould fungi and on pollen.

Some Psocoptera are synanthropous. They usually live in houses, in museums, in libraries and in other buildings, where they are almost unnoticed because of their hidden way of life. The most widely distributed vermin of this group in buildings is *Troctes divinatorius* Müll. It is also called the mould louse or the cabinet louse, though its similarity with a louse is only superficial.

Literature on the biology and the ecology of the book-louse is rather sparse. The most thorough and interesting examinations on the ecology of this species have been carried out by Ghani (1951) and Brown (1952) and on its anatomy by Kolbe (1880) and Noland (1924).

The booklouse is cosmopolitan. In buildings it is found on walls, in cupboards, behind baseboards, behind fixtures and behind water supply equipment. This insect is almost omnivorous, living on practically all kinds of animal and plant matter. The booklouse may be found in collections of insects, and other dried animals, in herbaria and in stack-rooms, between books and papers, especially in moist places. It destroys books, wallpaper and photographies, eating out the glue and the starch. It may also be found in dried fruits, in flour, in grain and in other products. However, some authors assume that the booklouse lives exclusively on mould fungi and does not destroy material that is to be preserved. We do not agree with this opinion, as it is contradictory to our observations.

In stack-rooms the booklouse appears sometimes in large quantities. Insufficient knowledge of the way of life of this species made us study the influence of different temperatures and different degrees of humidity on the booklouse. Knowledge of these factors may be of considerable value in creating such conditions in library buildings as are unfavourable to the

development and the reproduction of this vermin. – We have also studied the nutrition of the booklouse.

Experimental Method

A culture of booklice in weighing bottles, on wheat-flour, on dried meat, on cloth and on woolen material was placed in an insectarium with room temperature and moist air. For our experiments we took insects from this culture and placed them in chambers of plasticine which we put on slides. The champers were 8 mm in diameter and 4 mm in height and covered with a dense cloth of silk or satin. Crimbs of wheat-flour or dried meat were used as food.

We made daily observations of the booklice and studied their nutrition on wall-paper, newsprint and paper made of rags, and on the same sorts of paper processed with farinaceous glue, with and without antiseptics and with the sodium salt of carboxymethyl cellulose. We made further studies of their nutrition on new and old russet-tanned leather and new chrome leather, on old and new parchment, on calico, on imitated leather, on natural and on artificial silk, on cloth, on wheat-flour and on dried meat.

One series of experiments was made under room conditions, i.e., at the temperature and percentage of humidity of the insectarium. Another series of experiments was made at the temperature of the insectarium and 80 % air humidity. The experiments lasted approximately 2 years. For our work we used imaginal booklice from the stock culture fed on wheat-flour and dried meat. The insects were put in chambers of plasticine, which were covered with a dense cloth of silk. The chambers were circular with a diameter of about 8 mm and placed on slides. Each chamber contained 1 imaginal specimen. Also chambers intended for 10 specimens were used. These were oval, up to 3 cm long and 1.5 cm broad.

Observations of the Development of the Booklouse

Our first subject was to examine the influence of air humidity on the viability of the booklouse. To this purpose 20 imagines were placed in chambers of plasticine and later in desiccators with a constant air humidity from 10 % to 100 % (with an interval of 10 %).

Above 30 % of humidity the insects developed normally. Nymphs developed from the eggs laid by the imagines. The largest number of eggs was laid at air humidities of 80 % and 90 %. In chambers with 100 % air humidity we observed an intense growth of mould fungi whose hyphae completely covered the nutritional substrate and filled the chamber. It is probable that the development and the reproduction of the insects was suppressed by drop formation (Table 1).

Table 1: Survival rate of *Troctes divinatorius* Müll. at different percentage of relative humidity

20 samples were used at the experiment

Air humidity in %	Mortality in %	Day of death	Progeny (number of nymphs)	Remarks
10	100	14	—	90 % died on the 6th day
20	100	10	—	90 % died on the 6th day
30	100	14	—	90 % died on the 6th day
40	—	—	19	
50	—	—	19	
60	—	—	10	
70	—	—	17	
80	—	—	48	
90	—	—	55	Nutrition on mould fungi
100	—	—	15	Drop formation and excessive development of mould fungi

Smaller quantities of mould fungi have been observed in the chambers at 90 % humidity. In this case the fungi had no strong effect on the insects, on the contrary, they were used for nutrition.

In 1952 Brown studied the influence of 25 different combinations of temperature and humidity on various phases in the development of *Liposcelis (Troctes) divinatorius* Müll. He showed that the most favourable condition for oviposition, incubation of eggs, development of nymphs and lifetime of the imagines is a combination of 85 % of air humidity and a temperature of 20 – 25 °C.

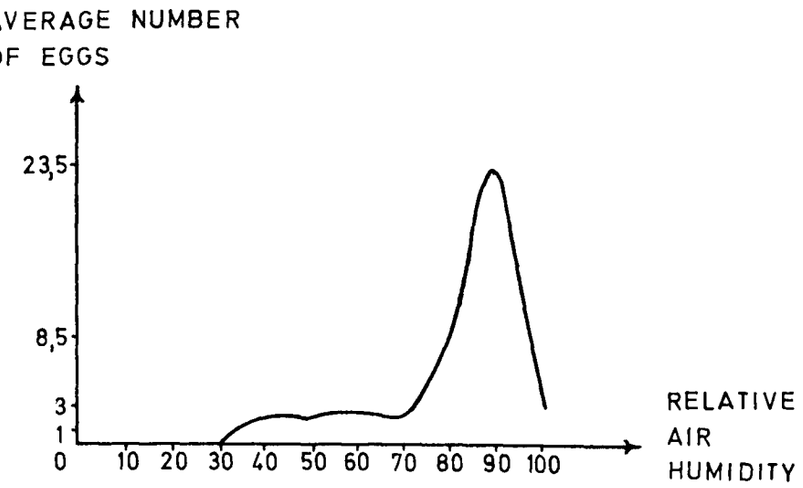

FIG. 1. Fertility of Troctes divinatorius Müll. at different percentages of air humidity and room temperature.

After the results of the first experiments we studied the influence of air humidity (from 10% to 100% with intervals of 10%) at variable room temperature. To test the humidity in this series of experiments we took 3 of the oldest nymphs at a time and kept each in a separate chamber. These nymphs developed into imagines and laid eggs (the reproduction of the booklouse is parthenogenetic). Each egg was then placed in a separate chamber. We noted the lifetime and the fertility of the imagines at each stage of humidity.

At 10%, 20% and 30% humidity all the nymphs died, their average lifetime being 6, 6, 8, 3, and 13 days respectively (Fig. 2). The nymphs lost water, and they became short and flat.

At 40% humidity all the nymphs developed into imagines which laid eggs. No female laid more than 3 eggs. The second generation was less viable, only in one case a nymph developed into imago. It lived 355 days, but did not lay a single egg (Fig. 1 and 2).

The maximum lifetime of an imago of the first generation at 50% humidity was 300 days. The largest number of eggs laid was four. The nymphs of the second generation had rather a long lifetime (181 to 193 days), but they died before they had reached maturity. Of this generation only 1 nymph developed into imago. However, it died after 370 days, and it never laid eggs.

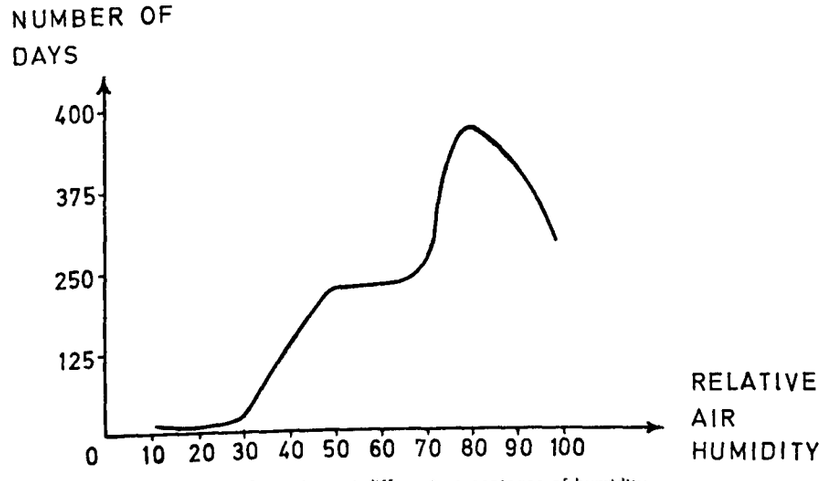

FIG. 2. Lifetime of imagines at different percentages of humidity and room temperature.

The imagines originating from the nymphs used for the experiment lived 160–341 days at 60% humidity. The largest quantity of eggs laid by a female was 5. All the nymphs of the second generation died before they had been transformed into imagines, though some of them lived quite long (up to 252 days).

At 70% air humidity the lifetime of the first generation was longer than at lower degrees of humidity. Some insects lived more than 470 days. Part of the nymphs of the second generation died. The nymphs which reached maturity were alive for more than 245 days. At this percentage of humidity a third generation was developed, but much more slowly. For instance, one nymph reached only the second stage of a nymph after 141 days.

At 80% humidity the development of the booklouse was considerably faster. Simultaneously the lifetime of the imagines was increased. In most cases they lived for more than 470 days. In our observations we noted a parthenogenetic development of 5–6 generations. The quantity of eggs produced by a female reached 20–23.

At 90% humidity the development was also fast. Within 18 months 6 generations had developed. The lifetime of the imagines was quite long (180 to 257 days). The number of eggs laid by a female was larger than the number of eggs produced at 80% humidity (Fig. 1).

The average number was 25–30, and in one case it was as high as 114.

At this percentage of humidity mould fungi developed in the chambers on the nutrition substrate, and the nymphs as well as the imagines lived on spores and hyphae of fungi. We found the following species of mould fungi: *Aspergillus flavus* Link, *Penicillium meleagrinum* Biourge and *P. tardum* Thom.

The development of the booklouse at 100% humidity was suppressed by intense growth of mould fungi, which almost filled the chambers, and by drop formation. Booklice of the second generation died after 300 days, at the imaginal stage. In the second generation only 1–3 eggs were produced. In the third generation there was only one nymph. It lived for 164 days and did not reach maturity.

The most favourable condition for the development, the lifetime and the fertility is a humidity percentage of 80–90%, at varying room temperature.

We also made a series of experiments at a constant temperature of 25° C. at 40%, 60% and 80% humidity. Our observations, which we had to stop for technical reasons, lasted 8 months. We took 6 imagines at a time and kept them in separate chambers, at each percentage of humidity. As soon as the booklice had produced their first eggs, they were transferred to the general culture, whereas the eggs remained in the chambers. We noted the speed of the development of each stage, and observed their lifetime and fertility.

It is probable that air humidity has not an immediate effect on the time of the development of the booklice. The time of development of the eggs does not differ considerably at different percentages of humidity (Table 2).

TABLE 2: Duration of the development (in days) of the booklouse at a temperature of 25° C.

Air humidity in %	Generation	Number of replications	Eggs	Nymphs of the 1st stage	Nymphs of the 2nd stage	Nymphs of the 3rd stage	Nymphs of the 4th stage	Imago
40	I	6	11.5	10	—	—	—	—
60	I	6	11.0	17	34	37	—	—
80	I	6	11.4	4.6	3	4.2	4.5	1.2*
80	II	83	11.3	13	6.8	5	5	—

* Editor's note: This must be the preoviposition period, cfr. the lifetime in Table 3.

As the nymphs grow their development becomes slower and slower. At 60% air humidity the development takes 17, 34 and 37 days; these figures apply to the first, the second and the third stage, respectively. In the first generation the development of each stage of nymphs takes 3–5 days at 80% humidity. In the second generation the development of nymphs of the first stage lasted longer than it did for the preceding generation. In the second generation the average time of development (from the oviposition to the imago stage) had increased two times as compared with the first generation.

At 80% humidity the booklice reached maturity after 29 days in the first generation, after 58 in the second generation and after 41.6 days in the third generation (Fig. 3). In the first generation the difference between the extreme values is very small. In the second generation it increases abruptly.

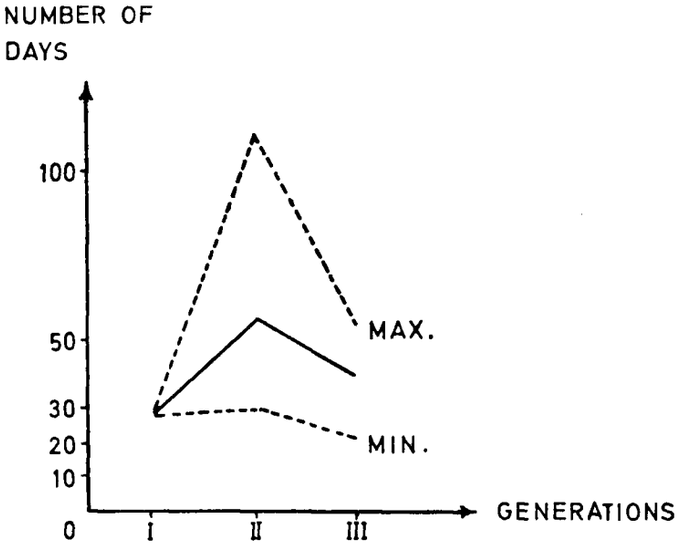

FIG. 3. Change of the periods of development according to generations at 25° C. and 80 % air humidity.

In the third generation these sizes are noticeably approximated. The development of the booklouse is oscillating.

The booklice reached maturity at 80% air humidity. At 60% air humidity one imago was developed. It is therefore difficult to judge of the lifetime of the imagines and of their fertility.

A comparison of the lifetime of the imagines according to generations at 80% humidity shows a reduction in their lifetime (Table 3).

At the same time the fertility is reduced, which clearly appears from Table 3.

TABLE 3: The lifetime of imagines and their fertility at 80 % humidity and a temprature of 25° C.

Generation	Number of replications	Lifetime			Fertility		
		Maximum	Minimum	Average	Maximum	Minimum	Average
I	6	165	37	95.7	75	7	38.7
II	22	113	4	65.1	71	3	23.6
III	12	67.6	35.7	50.2	27	2	18.5

A graphic representation of these sizes shows gradual approximation of the extreme sizes and the average size to the third generation (Fig. 4 and 5).

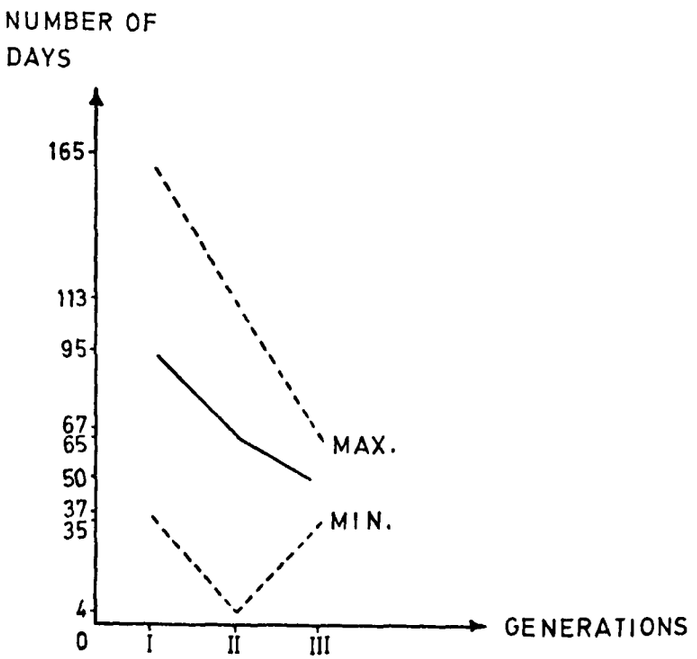

FIG. 4. Change of the fertility according to generations at 25° C. and at 80 % air humidity.

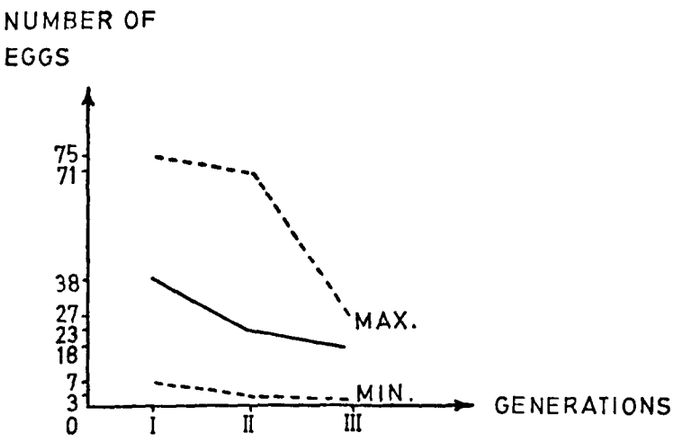

FIG. 5. Change of the lifetime of imagines according to generations at 25° C. and 80 % air humidity.

In the last series of experiments the optimal humidity at a temperature of 25° C. was 80 %, but, apparently, constant conditions have a depressing effect on ensuing generations, which is seen from the reduction of the fertility and the lifetime of the imagos. It should, however, be noted that the difference between the first and the second generation is larger than the difference between the second and the third generation. In our opinion it might be supposed that the difference between ensuing generations will be reduced more and more and that the curve will oscillate around a medium level, which is lower than the original level.

THE NUTRITION OF THE BOOK-LOUSE

Studying the nutrition of the booklouse we have observed that of the diets tested wheat-flour and dried meat (Tables 4 and 5) were most favourable for their development.

In our experiments some generations were developed on each of these substrates. The number of generations in the second series (at constant humidity) could be determined only with difficulty, as the generations were mixed, and the number of specimens increased to 100–200. Under room conditions (variable temperature and air humidity) we observed 2–3 generations. Further observations were stopped, though the insects were still alive.

TABLE 4: The nutrition of the booklouse at room temperature and air humidity

Material	10 nymphs in each chamber			1 nymph in each chamber		
	Degree of damage done to material	Lifetime in days	Number of generations	Degree of damage done to material	Lifetime in days	Number of generations
Art paper	—	376	2.3	—	49.6	1.3
Art paper with flour glue without antiseptics	—	365	2.3	—	120	1.6
Art paper with flour glue with antiseptics	—	353	2.6	—	201	2.0
Art paper with sodium carboxymethyl cellulose	—	361	2.3	—	73	1.3
Newsprint	—	381	2.0	—	71	1.3
Newsprint with flour glue without antiseptics	—	353	2.3	—	124	1.3
Newsprint with flour glue with antiseptics	—	353	2.0	—	162	2.0
Newsprint with sodium carboxymethyl cellulose	—	364	2.3	—	152	1.6
Paper made of rags	—	394	2.0	—	151	1.6
Paper made of rags with flour glue without antiseptics	—	324	2.3	—	153	1.6
Paper made of rags with flour glue with antiseptics	—	236	1.6	—	247	2.0
Paper made of rags with sodium carboxymethyl cellulose	—	372	2.6	—	219	2.0
New russet-tanned leather	×	420	2.6	×	207	1.6
Old russet-tanned leather	×	262	2.3	—	152	1.6
New chrome leather	×	349	2.3	×	119	1.3
New parchment	—	346	2.3	—	166	1.6
Old parchment	—	346	2.3	—	156	1.6
Calico	—	250	2.0	—	19	1.0
Leatherette	×	363	2.3	—	166	1.6
Natural silk	×	358	2.3	—	179	2.0
Artificial silk	×	339	3.0	×	160	2.0
Cloth	+	339	2.0	+	135	2.0
Wheat flour	+	483	4.0	+	339	3.0
Dried meat	+	445	3.3	+	144	1.3

Signs: No damage: —, Partial damage: ×, Considerable damage: +.

TABLE 5: The nutrition of the booklouse at room temperature and at 80% air humidity

Material	Degree of damage done to the material	Lifetime of all generations in days	Number of generations
Art paper	—	549	2.0
Art paper with flour without antiseptics	—	451	2.0
Art paper with flour with antiseptics	—	189	2.0
Art paper with sodium carboxymethyl cellulose	—	619	2.5
Newsprint	—	376	1.5
Newsprint with flour glue without antiseptics	—	223	1.5
Newsprint with flour glue with antiseptics	—	258	2.0
Newsprint with sodium carboxymethyl celluose	—	383	2.0
Paper made of rags	—	460	2.0
Paper made of rags with flour glue without antiseptics	—	280	2.0
Paper made of rags with flour glue with antiseptics	—	262	2.0
Paper made of rags with sodium carboxymethyl celluose	—	623	3.0
New russet-tanned leather	×	589	3.0
Old russet-tanned leather	×	473	2.5
New chrome leather	×	451	2.0
New parchment	—	451	2.0
Old parchment	×	533	2.0
Calico	—	311	2.0
Leatherette	—	371	1.5
Natural silk	+	606	2.5
Artificial silk	+	396	2.0
Cloth	+	606	3.0
Wheat flour	+	more than 679	not established
Dried meat	+	589	not established

Signs: No damage: —, Partial damage: ×, Considerable damage: +.

We noticed considerable damage on the cloth, which they torn asunder and changed into single small fibres.

We also noted that essential damage had been done to artificial and natural silk. The booklice devoured the eggs they had laid; besides, they fed on the mould fungi *Aspergillus restrictus* G. Smith, which developed in the natural silk.

Inconsiderable damage was observed on the fleshside of old and new russet-tanned leather and in new chrome leather. We found a large quantity of excrements, the colouring of which was the same as the colouring of the leather. As they apparently did not digest the leather we concluded that they had used their eggs as nutrition.

In old and new parchment the damage was insignificant. However, we found plenty of excrements of a white colouring, and we observed that letters had been stripped off old parchment, so that only traces of them were left.

The damage done to the calico and the leatherette was hardly noticeable. But there is no doubt that these materials had been damaged, since we found many blue excrements in the chamber with the leatherette and a large portion of excrements of a light colouring in the chamber with the calico. The colouring of the excrements corresponded to the colours of the materials eaten. In the chamber with the leatherette the mould fungi *Aspergillus restrictus* G. Smith were developed.

We have not observed damage in all kinds of paper. We quite often found that eggs had been eaten by the booklice. On paper processed with the hemicellulose pasti sodium salt of carboxymethyl-cellulose common salt was crystallized out. This is apparently explained by the fact that a technical product was used. At 80 % air humidity a large number of mould fungi were developed on all the samples of paper. On art paper we found the fungi *Penicillium notatum* Westling, on newsprint the fungi *P. meleagrinum* Biourge, *Hormodendron* Bonorden, and of the group *Aspergillus glaucus* we found: *A. repens* (Cda) de Bary and *A. restrictus* G. Smith. On paper made of rags we found *Penicillium notatum* Westling, *P. meleagrinum* Biourge, *Aspergillus flavus* Link, and *Hormodendron hordei* Bruhne.

We made one series of experiments with different quantities of nymphs in one chamber (1 or 10 nymphs in the same chamber). When we compared the results we saw that at a higher density the lifetime was considerably longer, the damage was more noticeable, and a large quantity of material was destroyed. The single specimens lived averagely two times longer than the specimens that were kept together. At a higher density we used the dead

bodies of insects for nutrition, and at the end of the experiments we were not able to detect a single dead body. However, we sometimes found capsules of heads. Besides, the booklice would quite often eat the eggs they had produced themselves.

In two series of experiments the density of the insects was the same, but the cultures were kept either at 80 % humidity or at variable room humidity. At a constant degree of humidity the lifetime was longer. Booklice are sensitive to humidity and prefer air humidity which is not below 40–60 %. In the course of 24 hours room humidity oscillated between 40 % to 85 %. The degree of damage was the same in both series.

The lifetime of *Troctes divinatorius* Müll. fed on paper processed with sodium salt of carboxymethyl cellulose at 80 % humidity considerably surpasses the lifetime at variable humidity. This is due to the fact that they lived on spores and hyphae of mould fungi, a very large quantity of which was developed on these samples of paper.

Conclusions

1. At room temperature the optimal air humidity for the development of the booklouse *Troctes divinatorius* Müll is 80–90 %.

2. At constant conditions the duration of the development changes from generation to generation.

3. Of the materials of which books are made booklice prefer cloth, artificial and natural silk and leather, new and old russet-tanned leather and new chrome leather; old parchment is partially damaged.

4. The higher the density of insects and of humidity the greater the damage done to the materials and the longer the lifetime of the booklice.

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Editor's note: Dr. Z. P. Baryshnikova's article was originally published in the Russian language under the title: *Nekotorye nablyudeniya za razvitiem i pitaniem knizhnoi vshi.* Sokhrannost knizhnykh fondov (sbornik materialov) 5 (1966): 100—13.

Reports of Conferences

Mass Restoration of Water-damaged Documents (Bückeburg, 17-18 February 1970)

The meeting was organized by the Niedersächsisches Staatsarchiv in Bückeburg, and attended by about 50 restorers. The majority of participants were from Germany but there were also representatives from Belgium, Denmark, England, Hungary, and Switzerland.

The coverage of the subject was comprehensive and discussions covered subjects ranging from administration and air-conditioning to specific problems of lamination and materials.

Papers were read in German and English, and written translations were provided.

The following papers were read:

Organization and methods of mass-restoration in Bückeburg
(Mr. H. Hofmann, Bückeburg)

Comparison of methods of mass-restoration in European countries
(Mr. A. Arad, Jerusalem)

Methods of mass-restoration in East Europe
(Mr. J. Ries, Zürich)

Deacidification and disinfection in mass restoration
(Mrs. L. Hasznos, Budapest)

Methods in use with mass conservation of archival paper-material
(Mr. H. P. Pedersen, Copenhagen)

Foils and Methylcellulose
(Dr. J. Friedrichsen, Düsseldorf)

A visit to the laboratories in Bückeburg and lively discussions were additional highlights of a very well-organized and successful meeting.

A. Arad
Jerusalem

The Conference on the International Cooperation for the Preservation of the Book (Florence, 12-14 March 1970)

A conference on »the international cooperation for the preservation of the book« took place in Florence 12–14 March 1970. It was organized by the Central National Library of Florence (Biblioteca Nazionale Centrale di Firenze, BNCF) in collaboration with UNESCO and the Italian Ministry of Education (Ministero di pubblica istruzione) and took place in the pleasant surroundings of the Palazzo dei Congressi. The conference which had more than hundred delegates was very well organized. In particular the delegates appreciated the almost breathtaking activity of the two interpreters who highly deserved the applause they received from the audience at the end of the conference.

The chairmanship of the conference was shared between Sir Frank Francis, of the Council on Library Resources, Washington, and dr. Harold J. Plenderleith, of the UNESCO Rome Centre, and as might be expected the proceedings of the conference were conducted in a dignified way with an occasional touch of humour.

In his inauguration address prof. E. Casamassima, the Director of the BNCF, remembered of the conferences formerly organized on the preservation of books and documents, reaching from the conference in St. Gallen in 1898 up to the conference on mass-preservation in Bückeburg in 1970. Each of these conferences had more or less focused on the technical aspects of library and archive preservation. In contrast the present conference would be related more to the organizational and administrative aspects of book preservation. Prof. Casamassima described how the flood on 4th November 1966 indirectly had made Florence the proving ground of what international cooperation may lead to. In this respect he particularly thought of the restoration laboratories at the BNCF. He described how the idea of organizing an international centre for the preservation of books and documents in Florence was conceived already during the early weeks of the rescue operation and how this idea eventually grew and led to the establishment, by international cooperation, of the restoration laboratories at the BNCF. These laboratories were not what was originally conceived and prof. Casamassima thought that a proposal for the establishment of a truly international centre for research and training regarding the preservation of books and manuscripts, which would be put forward later, would

be a major theme for the discussions of the conference, and he hoped these discussions would lead to a positive result.

The directors of the Department of Restoration (Reparto di Restauro) of the BNCF, dr. Luigi Crocetti and Mr. Anthony Cains had prepared a paper (read by dr. Crocetti) which dealt with the experiences in international cooperation at the restoration laboratories of the BNCF. The paper first described the enormous task of exsiccation of the flooded materials from the BNCF and the different mechanical and biological damages the material had suffered. Next the treatments used for different categories of damages were discussed. Further it was described how the restoration laboratories were established at the BNCF and how, particularly through the energetic efforts of the British colleagues, the »restoration system« of the BNCF was developed. A rather detailed description was given of the structure and functions of the system, and at last the experiences obtained in getting book conservators and restorers from a number of countries cooperate in the laboratories of the BNCF were described. The latter part of the paper formed an introduction to the visit the delegates were to pay to the BNCF during the afternoon session, and to those of the delegates who had not on former occasions visited the BNCF this visit apparently became a rather breathtaking experience.

According to traditional points of view the preservation of a book is something which should be done from beginning to end by one and the same person. However, the restoration system employed at the BNCF is a true mass-preservation system, based on an »assembly-line« concept, and operating with a number of highly specialized single functions. To many this may sound odd, but apparently this system is the only feasible solution to the enormous restoration problem at the BNCF, and whether you like the idea or not, it works extremely well. The delegates were taken through the laboratories by the directors of the Restoration Department, dr. Crocetti and Mr. Cains, assisted by the chemist of the department, Mr. Joe Nkrumah. Everything was well explained and demonstrated and the many questions made by the delegates were satisfactorily answered. During the visit the specification card which is an integral part of the restoration system was explained in detail and a demonstration was given of how it works in practice.

In the morning session of the second day of the conference the principal events were the papers read by Mr. Peter Waters and Mr. James Lewis, both of the Imperial College, London. Mr. Waters demonstrated the unsatisfactory state of affairs inside book preservation to-day, where the tra-

ditional practices are still almost dominant since very little has been done to relate the results of modern scientific research with restoration practice, probably mainly because there is too little communication between librarians, restorers and scientists. He pointed out that there appears to be a real need to establish a centre based upon an existing department of conservation and able to profit from its material and experience but devoted to research and training. In consequence Mr. Waters put forward a proposal to establish an international training centre for conservation of books and manuscripts. He mentioned that a small pamphlet with a questionnaire had been sent out jointly by the Conservation Group in London and the BNCF to directors of major libraries and archives throughout the world, and that the response to the question of an international centre was overwhelmingly in favour of it. It was briefly described what would have to be included in the training programmes of an international centre and strong and valid arguments were made in support of placing the centre in Florence.

Mr. James Lewis next read a short paper which in certain respects amplified the points of view regarding the international centre already expressed. Mr. Lewis pointed out that in some countries national centres of conservation already exist while in other countries no such comparable institutions exist at present. He thought that an international centre could act as an inspiration and model to those countries with limited resources until their own national centres are well established, and could play an important role in developing the field of book conservation. He sketched how the staff to instruct the students at the centre could be invited as visiting professors and and thus would not need to be away from their own responsibilities and workshops for excessive periods of time. Mr. Lewis mentioned that the pamphlet outlining a proposal for an international centre had been circulated to 210 institutions and individuals in 34 countries and that out of those who had answered the questionnaire 96% had been in favour of the proposal, while more than 50% had expressed a wish to use the facilities that could be offered by such a centre and would be prepared to send to the centre staff members who were already professionally trained in some capacity or the other, f. inst. as librarian, archivist or conservator.

Dr. Emerenziana Vaccaro, the Director of the Istituto di Patologia del Libro, Rome, read a paper in which she gave a very detailed account of the international activities and research projects involving one or more other countries in which the institute had taken part over the years since its establishment in 1938.

In the afternoon session Mr. Paul Banks, of the Newberry Library,

Chicago, demonstrated through a series of colour slides the decrease in binding standards which has occurred over the centuries, and after that Mr. Frazer G. Poole, of the Library of Congress, Washington, read the principal paper of the session. Mr. Poole first outlined the historical development of library conservation in the USA and then described in detail the preservation program of the Library of Congress after the reorganization in 1967 which was the result of the recognition of the library administration of the importance of book conservation and of the need to centralize and coordinate all preservation activities if the program was to be fully effective. He mentioned that the head of the preservation program is an Assistant Director of the Administrative Department, the department in the library which is responsible for the service and housekeeping functions, and described next how the preservation activities of the Library of Congress are organized in five basic sections: the Binding Office, the Restoration Office, the Preservation Microfilming Office, the Collections Maintenance Office and the Preservation Research and Testing Office. Of these five sections the four are operating while the fifth, the Research Laboratory, is in the process of being established. After having described the responsibilities of the headquarters office for preservation and the preservation budget Mr. Poole pointed out that the preservation program at the library is proving effective although not all problems have been solved yet. He thought that other research libraries might apply the same general organizational pattern in establishing their preservation departments but stressed that it must be recognized that preservation is expensive.

Mr. Poole next discussed the difficulties of recruiting skilled people for preservation work, as well as the curious lack of interest on the part of the libraries of establishing preservation programs. However, he thought that American research libraries are being stimulated to a renewed interest in book conservation by the publicity which has attended the tragedy of Florentine libraries, as well as by the development of such preservation programs as that operating at the Library of Congress. He was optimistic about the future of book conservation if the momentum and the interest that now exists can be maintained. One way of doing this, he thought, would be to establish the proposed international centre in Florence. Mr. Poole concluded with the remark that the concept of an international centre in Florence was an example of the right idea, in the right place, at the right time.

The afternoon session of the second day of the conference ended with a number of minor contributions and short remarks, which were continued

saturday morning during the final session of the conference. The representative of UNESCO, dr. A. Wagner, very strongly urged the conference to reach a conclusion regarding the proposal for the establishment of an international centre in Florence, and the representative of IFLA, dr. J. Wieder, proposed some secondary activities which might be helpful to the international cooperation in the field in question.

The Director-General of the Italian libraries, although he had certain reservations, was very positive about the establishment of an international centre in Florence, and after some summarizing remarks by prof. Casamassima the audience accepted with overwhelming majority the proposal of the Florenc centre. Next the members for an organizing committee were nominated and accepted by the audience. With this the conference had come to an end and there was only left for prof. Casamassima in a few elegant words to close the conference.

Immediately thereafter the delegates went to a restaurant in Piazza Signoria where an official, but wonderfully informal, farewell-lunch was served.

After lunch the »Organizing Committee for the Study of an International Centre for the Preservation of Books and Documents« met at the Palazzo dei Congressi and started its work. After having discussed a plan for its work the committee decided to meet again by the middle of June, after the members have, in sub-committees, considered the different problems connected with the establishment of an international centre. The meeting in June may be expected to result in a detailed plan for the establishment of the centre which may be put before UNESCO in time before its General Conference in Paris in October this year.

Appendix

Titles of the principal papers read at the conference:

Dr. Luigi Crocetti and Mr. Anthony Cains:
Un'esperienza di cooperazione internazionale.

Mr. Peter Waters and Mr. James Lewis:
Requirements for an international Center for Preservation of Books and Manuscripts.

Dr. Emerenziana Vaccaro:
Attivita dell'Istituto di Patologia del Libro nella cooperazione internationale.

Mr. Frazer G. Poole:
Planning a preservation programme in a major library.

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By some mistake Sir Frank Francis, of the Council on Library Resources, One Dupont Circle, Washington, D.C. 20036, U.S.A., forgot to include his own name when he read the list of those nominated and accepted as members of the committee. Sir Frank Francis therefore should be added to the list of members of the committee.

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