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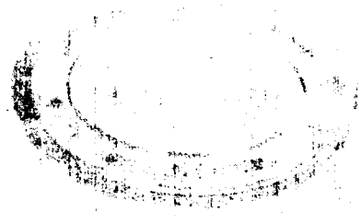

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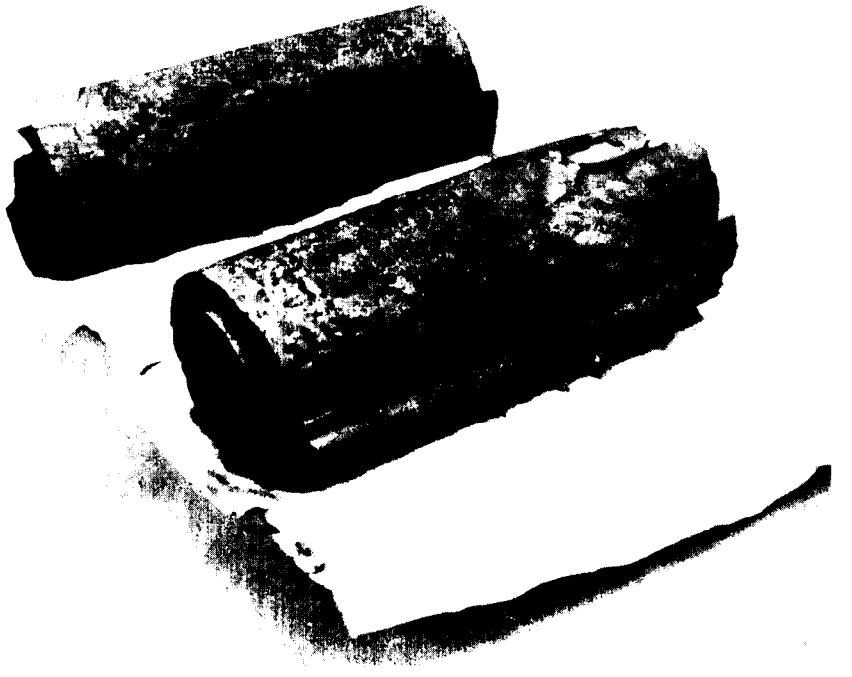

PLATE 1. The copper scroll before opening.

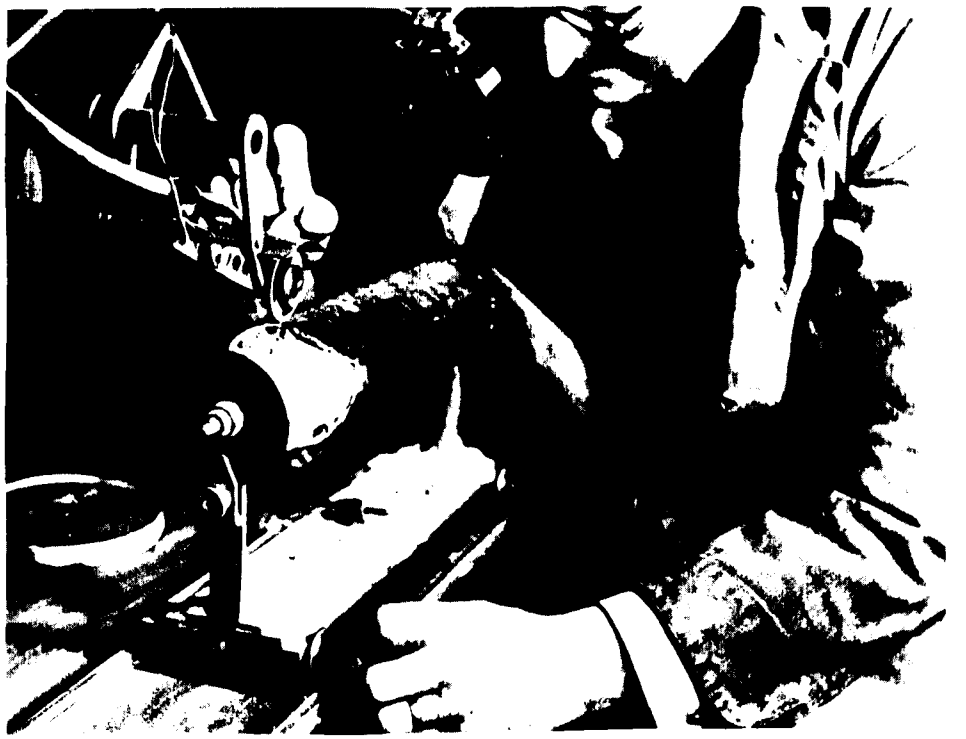

PLATE 2. Dr. H. W. Wright Baker cutting the copper scroll.

PLATE 3. Open segment of the scroll.

Beginning of the scroll. Line transcription.

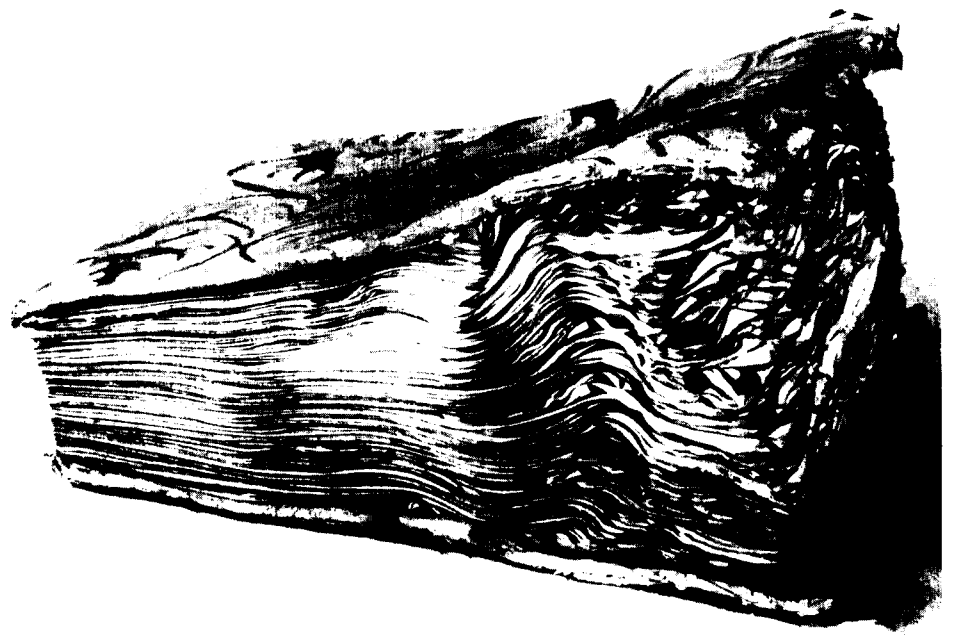

FIG. 1. Ptolemy's »Geography« (published 1511) before processing.

FIG. 2. Same after restoration.

Selecting and Testing Adhesives for the Restoration of Skin-bindings and Parchments

by I. K. BELAYA

Glues are of the utmost importance to the quality of restoration processing, and consequently to the strength and durability of the material to be restored. When selecting glue not only the strength of the parchment, but also the physico-chemical properties of the glue and any interactions between the glue and the material to be restored must be considered. The following properties are required of glue for the restoration of skin bindings and parchments:

1. It must not be destructive to the skin, the cardboard, or the paper on binding-covers when applied for long-time preservation, neither must it spoil the surface of the skin.
2. It must be resistant to environmental effects such as temperature, moisture and oxygen in the air.
3. It must paste the material together solidly.
4. It must have excellent adhesive properties.
5. It must not be susceptible to bacterial rotting or moulding.
6. It must be convenient to work with.

Adhesive agents now used for binding work do not meet these demands. Thus, glutinous glues (osseous glues, skin glues and gelatine glues, etc.), which are applied for the most important bindings and have numerous valuable properties, are good adhesives and make very solid pasting, will be covered by a coarse and very brittle film at long-time preservation. Skin pasted together with osseous glue will become hard during long-time preservation, it will easily break and fissures will be formed. Dextrin glue used for different kinds of work in the binding industry also gives a very brittle film and has insufficient adhesive capacity. Acid dextrin is capable

of destroying the skin. Glue made of rye flour or wheat flour is not harmful to the skin, but it does not give a sufficiently solid pasting, and it will easily rot. All natural glue substances, animal substances, as well as plant substances rot easily and are susceptible to mould, and wherefore antiseptic treatment must be applied. In addition, these glues attract insects which destroy them. We studied animal substance glues, plant substance glues and synthetic glues in order to select the glue with the best qualities. As for animal substance glues we studied the effect on skin of an osseous glue of 47 %, a gelatine glue of 27 %, and a sturgeon glue of 15 %. As regards plant glues, we studied a 7 % glue of wheat flour, the so-called restoration glue, and a 70 % dextrin. Of synthetic glues we studied the polyvinyl alcohol group:

1. Polyvinyl alcohol, 15 %.
2. Polyvinyl buthyral (butvar), 15 %.
3. Polyvinyl acetate, 15 % and 30 %.
4. A polyvinyl acetate emulsion of 33 %.
5. A perchlorate vinyl glue of 37 %.

Among cellulose glues were studied:

1. Ethyl cellulose, 12 % and 15 %.
2. Sodium salt of carboxymethyl cellulose, 10 %.

We further studied polymethyl acrylate in the form of a 10 % water suspension, a 15 % water suspension and a 29 % water suspension, and a group of polyamide glues, namely: The methyl-polyamide glue PFE 2/10, 23 %, and a mixture of the polyamides 548 and 54. On the basis of these investigations which were completed in 1954, we arrived at the following conclusions:

1. Of natural glues a 15 % sturgeon glue best meets the demands of skin-bindings, since it gives a solid and elastic film which changes little with time. The drawback of this glue is its tending to disintegration if attacked by bacteria and its susceptibility to mould and moisture, which calls for antiseptic treatment.

2. Of synthetic glues, ethyl-cellulose and polyvinyl alcohol (Table 1) give a solid and sufficiently elastic film, which remains almost unaltered.

3. Vinyl-perchalorate glue, which is used in the footwear industry, gives a solid pasting but it is unsuitable for the restoration of skin bindings of

old books, as perchlorate vinyl tar contains haloids which at long-time preservation will destroy the skin of bindings. In addition, the glue has a very penetrating smell of the solutions in which the vinyl perchlorate tar is dissolved (amil acetate, acetone and benzine).

4. Polymethyl acrylate, which forms an elastic film, gives a less solid pasting as compared with ethyl cellulose, polyvinyl alcohol and other synthetic glues.

5. It is a drawback in polymethyl acrylate and polyvinyl alcohol that skin processed with these glues will mould under moist conditions.

6. According to literature and to information from our mycological laboratory, ethyl-cellulose glue is less susceptible to mould. It should also be noted that this glue is not attractive to insects.

7. In 1955 we recommended a 12–15 % alcohol solution of ethyl-cellulose as a glue for restoration of skin bindings, and we have been working with this glue for some years. It should, however, be emphasized that ethyl-cellulose also has its drawbacks. The fundamental drawback is the slowness with which it settles. In 1955 we terminated investigations on ethyl-cellulose glue for the restoration of skin-bindings in our laboratory and then proceeded to selecting and testing other glues for skin bindings and parchments. This time we selected a group of polyamide glues. Polyamide glue is of special interest for the restoration of skin-bindings, as it has good adhesive and cohesive properties and chemically resembles albumin compounds. The composition of this very important class of synthetic glues corresponds to the general formula:

$$-NH-R-CONH-R-CONH-R$$

or:

$$-CO-R-CONH-R-NHCO$$

where R– stands for hydrocarbon chains with some methyl groups.

We may also define polyamides as compounds containing amide (CONH) groups between long hydrocarbon radicals.

The similarity of the chemical compositions of polyamides and natural albumin (wool, silk, and collagen skin) is seen in their capacity of absorbing water, their hygroscopicity and their air-penetrability, as well as in their interaction with acids and alkalies. In the same way as skin hair and collagen, polyamides react with basic salts of chromium and plant-tanning

TABLE 1: Physico-mechanical properties of new chromium leather (chromium tanned calfskin) processed with different glues before and after irradiation.

Name of the process	Load in kg (At rupture)	Extension in mm (At rupture)	Limit of strength in kg/mm²	Module of elasticity in kg/cm²	Hardness in kg	Remarks
Control before irradiation	21.50	20.70	2.64	1 025	825	10 hours
after irradiation	23.35	19.45	2.78	1 147	929	of irradiation
Glue of wheat flour						
before irradiation	22.67	25.45	2.67	993	854	
after irradiation	21.65	21.95	2.86	1 004	811	
Dextrin 70% before irradiation	23.90	19.17	3.17	1 249	885	
after irradiation	21.15	17.85	2.93	1 251	820	
Osseous glue 47%						
before irradiation	29.07	22.90	3.72	674	515	
after irradiation	26.25	21.80	2.67	730	554	
Gelatine 27% before irradiation	22.80	21.95	2.68	904	755	
after irradiation	23.80	23.05	2.88	743	628	
Sturgeon glue 15%						
before irradiation	23.32	19.58	2.70	800	612	
after irradiation	26.53	24.50	3.28	719	576	
Polymethyl acrylate 29%						
before irradiation	24.80	18.12	2.76	1 124	931	
after irradiation	23.83	25.72	2.98	791	590	
Ethyl cellulose 15%						
before irradiation	23.41	27.70	3.04	800	672	
after irradiation	24.06	23.64	3.04	760	617	
Butvar* 15% before irradiation	28.96	16.93	3.20	1 044	970	
after irradiation	27.05	17.98	3.17	1 043	917	
Polyvinyl acetate 30%						
before irradiation	28.41	22.77	3.31	753	643	
after irradiation	28.35	21.13	3.45	739	604	
Polyvinyl alcohol 15%						
before irradiation	27.10	23.93	3.42	823	616	
after irradiation	25.46	26.25	3.12	621	493	

* Editor's note: Cfr. page 222: 2. Polyvinyl butyral (butvar).

agents. It should also be pointed out that polyamides are not easily combustible.

When polyamides are heated their original elasticity and extensibility is increased. Long-time heating at more than 90–100° C leads to destruction of polyamides.

Polyamides are extremely resistant to mould fungi and bacteria.

This survey of the physical and chemical properties of polyamides shows that polyamide glue meets several demands of glue for the restoration of skin-bindings and parchments. We used the four polyamide glues: Methylol polyamide glue, PFE 2/10, in an original concentration of 23–24%; a 20% concentration of the mixed polyamides 548 and 54 – and a 24% concentration of the glue MPF. The glue MPF–1 was rejected after testing, as skin becomes hard to the touch when processed with this glue. We did not test the strength of polyamide glue, since as numerous works in this field report on great strength and good adhesion properties of the polyamides when applied to a series of materials, such as skin and tissues.[1, 2, 3] For all purposes it was more important to determine the properties of skin at long-time preservation after it had been processed with polyamides. To examine this problem groups of skin samples, composed according to the classical method with assymetric fringes were processed with glues on the frontside and the fleshside. After 6 months' suspension in air the physico-mechanical properties of the skin, i. e. its strength and elasticity were determined. A physico-mechanical analysis (of load and extension at rupture, load and extension at a tension of 1 kg, module of elasticity and the hardness) was carried out on the Schopper dynamometer with automatic registration of the properties. One of the samples was subjected to artificial aging, and irradiated with a mercury quartz lamp, PRK–2, at a distance of 30 cm, for 10, 50, 100 and 200 hours. The temperature of the surface to be irradiated was 40° C and the relative humidity of the air in the room within the limits of 50–60%. From the physico-chemical properties we determined the acidity and the humidity of the samples of the skin before and after irradiation. The acidity of the skin, the pH, of potassium chloride extract 0.1 N was determined by an LP–5 potentiometer, with a glass electrode. We determined the humidity by drying the granulated skin at a temperature of 80° C until a constant weight had been reached. Considering the data obtained at a physico-mechanical analysis of new chromium skin after processing with polyamide glues (Table 2) it should be emphasized that the polyamide glue no. 54 has a negative effect on such skin. The hardness

of the skin was considerably increased and the samples were reduced after aging. Processing the skin with the glue PFE 2/10, makes its strength after aging decrease to the same degree as is observed in the control samples. The degree of hardness is lower. Polyamide no. 548 does not change the elastic properties of new chromium skin, and the hardness is not changed after aging.

Comparison of the results of aging at 10 hours' irradiation, at 100 hours' irradiation and at 200 hours' irradiation shows that there is an increase of the hardness together with a reduction of the strength of the skin at 10 hours' irradiation. At 100 hours' irradiation decreased strength and increased hardness is also observed. The control samples with reduced strength and increased hardness are exceptions. At 200 hours' irradiation the strength is reduced and a considerable diminishing of the hardness is observed in the control samples as well as in the samples processed with the glues PFE 2/10 and no. 548.

Processing with polyamide no. 54 causes an increase of strength and a very considerable increase of the hardness. Thus the mixed polyamide no. 54 is the most resistant to ultraviolet irradiation of the polyamides as stated above. Table 3 contains the data from a physico-mechanical analysis of new and old tanned skin of different processing. It appears from the results of the analysis that processing of old tanned skin with methyl polyamide PFE 2/10 improves the quality of the skin; its strength has increased and its hardness has decreased. Similar results are obtained at processing of new tanned skin with PFE 2/10.

Data from a physico-mechanical analysis of old writing parchment and old binding parchment are given in Table 4. The strength of the writting parchment after 200 hours' irradiation is reduced in the control samples as well as in those processed by different methods. The least loss of strength is observed after processing with the glue PFE 2/10. After processing with PFE 2/10 the hardness is considerably reduced. Processing of binding parchment with the glue PFE 2/10 also gives a positive result. On the basis of the physico-mechanical analysis we may draw the following conclusions: Old and new tanned skin, old writing parchment and old binding parchment retain the best qualities after processing with the polyamide glue PFE 2/10. Processing of new chromium skin with polyamides does not deteriorate the qualities of the skin, neither does it produce any considerable improvement of its properties. A determination of the acidity of the skin shows that processing of the skin with these polyamides does not produce any considerable change in the acidity of the skin. Oscillations of

Table 2: Physico-mechanical properties of new calfskin processed with polyamides.

Name of the process	Load in kg (At rupture)	Extension in mm (At rupture)	Limit of strength in kg/mm²	Module of elasticity in kg/cm²	Hardness in kg	Remarks
Control before irradiation	19.21	31.57	2.66	328	235	200 hours of irradiation, i. e. 100 hours on the flesh side and 100 hours on the grain side
200 hours of irradiation	15.97	35.90	1.87	222	189	
PFE 2/10 before irradiation	17.45	28.40	2.13	373	305	
200 hours of irradiation	12.80	29.00	1.54	280	234	
Osseous glue 47 %						
before irradiation	18.00	32.55	2.23	325	262	
200 hours of irradiation	15.17	30.23	1.85	278	227	
Polyamide no. 548						
before irradiation	25.07	36.29	3.15	347	276	
200 hours of irradiation	21.50	37.50	2.65	340	275	
Polyamide no. 54						
before irradiation	19.84	32.15	2.48	226	180	
200 hours of irradiation	20.15	31.98	2.62	367	281	
Control before irradiation	25.01	34.70	2.64	277	264	50 hours of irradiation on the flesh side and 50 hours on the grain side
100 hours of irradiation	16.49	27.77	1.92	290	254	
PFE 2/10 before irradiation	23.35	33.20	2.44	335	332	
100 hours of irradiation	19.81	21.87	2.17	511	471	
Polyamide no. 548						
before irradiation	23.65	33.05	3.01	345	298	
100 hours of irradiation	21.05	27.25	2.72	478	425	
Polyamide no. 54						
before irradiation	23.60	33.60	2.33	349	352	
100 hours of irradiation	23.23	31.87	2.32	384	381	
Control before irradiation	25.01	34.70	2.64	277	264	10 hours of irradiation
PFE 2/10 before irradiation	27.90	33.15	3.09	417	374	
10 hours of irradiation	26.84	25.60	2.96	500	452	
Osseous glue 47 %						
before irradiation	29.07	22.90	3.72	631	473	
10 hours of irradiation	26.25	21.80	2.67	657	555	
Polyvinyl alcohol 15 %						
before irradiation	27.10	23.93	3.42	519	388	
10 hours of irradiation	25.46	26.25	3.12	523	415	
Polyvinyl acetate emulsion 33 %						
before irradiation	29.35	32.33	3.18	357	337	
10 hours of irradiation	21.40	32.27	2.28	278	267	
10 % KMT + 5 % glycerine						
before irradiation	24.30	33.10	2.61	333	310	
10 hours of irradiation	23.53	31.65	2.50	313	284	

TABLE 3: Physico-mechanical properties of old tanned leather processed with polyamides.

Name of the process	Load in kg (At rupture)	Extension in mm (At rupture)	Limit of strength in kg/mm²	Module of elasticity in kg/cm²	Hardness in kg	Remarks
Control before irradiation	10.30	7.15	1.20	1 234	1 042	200 hours of irradiation, i. e. 100 hours on the flesh side and 100 hours on the grain side
200 hours of irradiation	8.70	9.27	1.18	745	565	
PFE 2/10 before irradiation	9.47	8.46	1.18	1 282	1 014	
200 hours of irradiation	11.65	8.29	1.49	1 121	856	
Polyamide no. 548						
before irradiation	13.67	9.11	1.59	1 179	1 012	
200 hours of irradiation	10.20	8.20	1.34	985	746	
Polyamide no. 54						
before irradiation	13.12	6.55	1.70	1 455	1 123	
200 hours of irradiation	9.58	7.71	1.21	896	701	
Control: 10 hours of irradiation	7.30	5.10	0.92	1 384	1 094	10 hours of irradiation
PFE 2/10 before irradiation	7.18	6.70	0.96	884	653	
10 hours of irradiation	8.44	5.50	1.00	982	810	
Polyvinyl acetate emulsion 33 %						
before irradiation	7.10	10.30	0.91	518	428	
10 hours of irradiation	6.89	7.50	0.96	944	729	
10 % KMT + 5 % glycerine						
before irradiation	6.29	7.02	0.77	823	621	
10 hours of irradiation	5.88	5.65	0.78	1 250	929	
Physico-mechanical properties of new tanned leather						
Control before irradiation	15.51	21.00	1.75	416	355	10 hours of irradiation
10 hours of irradiation	11.71	20.50	1.76	432	436	
PFE 2/10 before irradiation	18.22	21.91	1.81	445	434	
10 hours of irradiation	18.22	22.01	1.90	400	381	

TABLE 4: Physico-mechanical properties of old writing parchment processed with different polyamides.

Name of the process	Load in kg (At rupture)	Extension in mm (At rupture)	Limit of strength in kg/mm²	Module of elasticity in kg/cm²	Hardness in kg	Remarks
Control before irradiation	41.75	9.02	6.17	4 165	1 466	200 hours of irradiation, i. e. 100 hours on the flesh side and 100 hours on the grain side
200 hours of irradiation	18.38	7.01	5.58	5 154	1 752	
PFE 2/10 before irradiation	19.48	6.45	5.82	4 762	1 375	
200 hours of irradiation	19.62	5.75	5.63	3 448	1 189	
Polyamide no. 548						
before irradiation	25.29	10.57	7.57	3 773	1 223	
200 hours of irradiation	23.04	9.83	6.98	3 496	1 143	
Polyamide no. 54						
before irradiation	24.70	9.15	7.50	3 448	1 134	
200 hours of irradiation	20.47	8.13	6.24	4 672	1 532	
Physico-mechanical properties of old binding parchment						
Control before irradiation	26.50	10.89	7.82	5 964	2 081	50 hours of irradiation, i. e. 25 hours on the flesh side and 25 hours on the grain side
50 hours of irradiation	26.36	10.45	7.25	10 000	3 630	
PFE 2/10 before irradiation	30.85	7.39	8.49	7 693	2 864	
50 hours of irradiation	25.27	10.37	7.75	5 512	1 792	

pH are within the permissible limits. Data on the humidity, as given in Table 5, show that processing with polyamides somewhat decreases the humidity and consequently the hygroscopic properties of tanned chromium and parchment skin. After 200 hours' irradiation the hygroscopic properties are slightly diminished.

On the basis of these data the following conclusions may be drawn:

Of the group of polyamide glues, the methylol polyamide glue PFE 2/10 best meets the demands on restoration glue for skin-bindings of old books and old parchments. Processing with the methylol polyamide glue, PFE 2/10, increases the strength and reduces the hardness of these skins. Considering the chemical and physico-chemical properties of the glue PFE 2/10

TABLE 5: Definition of pH and of the humidity of leather processed with polyamides.

Name of the process	pH	Humidity in %	Remarks
Writing parchment			
Control before irradiation	6.20–6.25	16.54	
200 hours of irradiation	6.25–6.25	16.67	
PFE 2/10 before irradiation	5.97–6.00	14.11	pH of a 1% alcohol solution of PFE 2/10 = 6.0–6.1
200 hours of irradiation	5.97–6.00	14.95	
Polyamide no. 548 before irradiation	6.00–6.10	13.92	
200 hours of irradiation	6.00–6.10	14.00	
Polyamide no. 54 before irradiation	6.00–6.00	12.11	
200 hours of irradiation	6.10–6.10	11.60	
Old tanned leather			
Control before irradiation	4.67–4.70	11.55	
200 hours of irradiation	4.80–4.80	11.67	
PFE 2/10 before irradiation	4.60–4.60	10.10	
200 hours of irradiation	4.77–4.80	10.80	
Polyamide no. 548 before irradiation	4.60–4.60	9.80	
200 hours of irradiation	4.70–4.70	9.15	
Polyamide no. 54 before irradiation	4.60–4.60	12.11	
200 hours of irradiation	4.77–4.80	11.60	
New tanned leather			
Control before irradiation	4.30–4.30	8.63	
200 hours of irradiation	4.30–4.30	8.15	
PFE 2/10 before irradiation	4.40–4.40	8.10	
200 hours of irradiation	4.30–4.30	8.10	
New chromium leather			
Control before irradiation	4.80–4.80	12.16	
200 hours of irradiation	4.50–4.50	12.80	
PFE 2/10 before irradiation	4.90–4.90	9.93	
200 hours of irradiation	4.90–4.90	10.93	

and the marked improvement of old tanned skin and old parchment after processing with this glue, we find that we may recommend it as a restoration glue for skin-bindings of old books and old parchments.

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Editor's note: Dr. I. K. Belaya's article was originally published in the Russian language under the title: *Podbor i ispytanie kleya dlya restavratsyii kozhanykh perepletov i pergamentov,* and appeared in: Sbornik materialov po sokhrannosti knizhnykh fondov. 4 (1961): [illegible]–19.

The Use of the Scanning Electron Microscope in Document Restoration Problems

by MARGARET HEY

Introduction

The work described in this paper arises from that begun by Dr. C. Edwards, Miss M. Hey, Mr. J. C. Lewis and Mr. P. Waters as a study of the problems involved in the removal of mud from books damaged in the Florence Flood of 1966 and published in *Graphis* No. 146, page 536. Dr. Edwards and Mr. Lewis used the scanning electron microscope on paper samples during an investigation of mud removal but it was not then known whether such surface studies would prove to be useful if continued in the rather specialised context of paper restoration. Thus the present programme of work using the Stereoscan Mark 2 A in the Department of Metallurgy, Imperial College and involving a different sampling procedure was undertaken and as the photographs demonstrate the information obtained from a systematic study has proved invaluable.

It is fully appreciated that so far these instruments have only a limited world-distribution and that the cost of time on an instrument makes their frequent use outside the bounds of possibility for most restoration institutes/workshops. But in spite of these restrictions it is felt that many restorers will appreciate the value of the photopraphs and will wish to know more about the working procedure involved and the possibilities of the instrument.

The Scanning Electron Microscope

The basic principle of scanning electron microscopy was first propounded by M. Knoll (Germany) in 1935. Although some work was done in the meantime it was not until 1952 that further developments by Professor Oatley, Department of Engineering, Cambridge University, resulted in the

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construction of a working instrument. An article on the potential applications of this method of investigation in fibre technology, especially paper, appeared in 1956.[1] But a machine based on the continuing developments made by Professor Oatly and his team was not commercially available until 1965 when Cambridge Scientific Instruments Ltd. marketed the Stereoscan.

Even in this short period the instrument has proved itself to be of exceptional utility in the general scientific field as can be read in the seminar proceedings.[2] References to particular applications which may be of interest in connection with the restoration of other works of art are cited separately – viz. paint films,[3] weathered wood[4] and rocks.[5] A general survey[6] may be found useful for non-specialists.

Applications of the technique to the general study of paper structure are considered in detail further on but the present article illustrates, we believe, its first applications to problems connected with the restoration and conservation of works of art.

The Instrument's Advantages

The instrument is the most convenient means of examining directly samples with rough surfaces, providing greater depth of focus at higher magnifications than is possible with light optical microscopy. This is because the very fine electron beam (of about 200 Å diameter) is virtually parallel at its tip and therefore is in focus not only on the upper surface but also into the depth of irregularities. The advantages of the scanning electron microscope over light optical microscopes can perhaps best be appreciated by comparing the admittedly very interesting surface replica photographs obtained by Emerton *et al*[9] using an optical light microscope, with those obtained by Buchanan and Lindsay[10] using scanning electron microscopy, or with those included in the present article. Transmission electron microscopy can only examine very thin films of material and in order to study a surface some kind of replica would have to be prepared. As Borgin points out in connection with his wood studies, this can lead to loss of important features when dealing with fibrous specimens, besides being a somewhat tedious procedure. In addition, using the Stereoscan, photomicrographs can readily be prepared showing topographical features in depth. Surfaces can be examined using optical light binocular microscopes but taking stereo micrographs which would preserve the sight of these

features can be complicated and the results obtained need to be viewed using special glasses (see, for example, the articles by Loose[7] and Kozlowski[8] on stereoradiography which appeared in *Conservation*).

True stereopairs, essential for *quantitative* examinations in depth of samples, can be prepared using the Stereoscan and for these also special viewing facilities are required.

Preparation of Sample

The maximum surface area which can be examined using this particular instrument is 1 cm diameter (other stages are, however, available which would take larger specimens especially when the sample in volume has to be studied and not only its top surface). Minimum sample size is difficult to specify – for example, the eight moon-rock samples examined on this machine were all about the size of a pin-point.

The sample for examination is mounted onto a small metal stub using double-sided adhesive tape. This has been found to hold the paper sufficiently firmly in position and there is no problem with possible penetration of the adhesive into the sample itself thereby giving misleading information as could occur were a liquid adhesive to be employed for the purpose.

If the sample under investigation were to be a conductor (for example, metals) no further preparation would be required. However, non-conductors such as paper need to be coated with a thin layer of metal. (Certain materials such as minerals, could be examined without this, using very low beam-voltages, but then there would be some loss of resolution).

At the beginning of this programme of work goldpalladium alloy was used for coating but since work being carried out contemporaneously on biological materials was giving better results when gold alone was used, this procedure was also adopted for all the later paper samples.

The samples are coated by vaporising gold at extremely low pressures. The stub is placed under a bell jar, then evacuated down to 5×10^{-4} Torr. pressure. When this is reached the gold (in the form of a length of wire resting in a molybdenum boat between two electrodes) is vaporised while the stub is revolving in its vicinity. (For economy of time and materials the maximum of six stubbs should, preferably, be coated at any one time).

The metal coating applied should be sufficiently thick to ensure complete coverage of the specimen, especially into deep surface irregularities, but should not be so thick that fine detail is thereby obscured. Its thickness is governed by the actual length of gold wire vaporised – that is, the longer

the length of wire, the thicker the coating. The layers applied for the paper samples studied were in the region of 100–150 Å thick. The coating should, if possible, be applied immediately before examination, but if this cannot be done the prepared samples must be kept in a desiccator over phosphorous pentoxide, preferably under vacuum as well. This is because paper is so susceptible to moisture that its dimensions will change thereby disturbing the metal coating.

This method of sample preparation does presuppose that the specimen not be damaged by the extremely low pressures necessary and that it not be wet. Biological samples which naturally contain large quantities of water have been examined either through the preparation of a surface replica or after freeze-drying. Both procedures are still subjects for controversy with respect to the amount of sample change which thereby results.

Observation of the Sample

The primary beam of electrons from the electron gun, after passing between three pre-aligned electromagnetic condenser lenses, is focussed into a fine probe. When this strikes the sample surface some electrons are reflected off but the majority penetrate into the coated sample. When they strike electrons in the metal film they knock them out of their energy shells. These low-energy secondary emitted electrons are drawn to a positively-biased scintillator/light guide/photomultiplier collector system. The signal produced after amplification is used to modulate the beam of the display tube.

Two visual display units are fitted on the machine. One, equipped with high-persistence phosphor, enables the whole of the sample area to be viewed simultaneously, although the electron beam itself is continuously traversing the surface. The other, equipped with low-persistence phosphor, enables photo-micrographs to be taken.

Photography

An Exa 1a, 35 mm camera, a standard fitting on the Stereoscan, was used throughout the work. The shutter is held open by a cable release which will lock for the duration of one complete scan. The speed, hence exposure time, is dependent upon the strength of signal available; the slower the scan the better the picture. The line and frame speeds are balanced to give at least 1000 lines per frame, otherwise the individual scan lines can be resolved on the photographs.

The exposure time was in fact 40 secs. using Ilford 35 mm Pan F fine grain panchromatic film and Kodak Panatomic X, developed in May and Baker 'Promicrol' using the 3:1 dilution technique in an 'Inversion' 35 mm developing tank, inverted every 30 sec. to full development time of 16 mins. at 20° C. (this gave fine grain and good shadow detail).

Agfa Rodinal developer has also been used with Panatomic X, 1:100 dilution for 15 mins. with equal quality of the negative image.

Choice of Beam Intensity

The same area on samples has been examined using 5 KV, 10 KV, 20 KV, and 30 KV beam intensities. The majority of the samples photographed have been examined at 20 KV. This has been found to give a more informative *general* picture of the paper. However, 10 KV and especially 5 KV provide very much more detail of the top fibre surfaces (although losing resolution in depth). From experience gained so far it would seem more useful to employ these low intensities when the restoration treatment being carried out on the paper involves possible fibrillar damage (for example bleaching) and to use the higher intensities to follow, for example, buffering processes. But in any case, it is extremely simple to change beam intensities (a matter of seconds in time) so that all possibilities can be explored. In the publications cited on previous work with paper, the beam intensities employed were not given.

Choice of Sample Area to be Photographed

When observing areas of such a non-uniform material as paper at these magnifications, there must always be caution when deciding how representative any photomicrograph is of the entire surface. Berg (q. v.) draws attention to this problem and takes at least 10 photomicrographs of his 1/4" sq. samples when using transmission electron microscopy. We have carried out similar total surveys of 1 cm diameter samples for the purposes of records. For normal investigations the entire surface is scanned before deciding on the areas to be photographed as characteristic. Features from which definite conclusions are drawn are therefore representative of the whole area. Occasionally, though, it must be confessed, photomicrographs are taken for their sheer visual interest alone (see, for example, illustrations 29, 30) but these must be considered apart.

Scanning Electron Microscope Investigations on Paper in General

Those so far published come from the Pulp and Paper Research Institute of Canada which was able to obtain an early prototype of the instrument from the Department of Engineering, Cambridge University, before the instrument became commercially available.

Work which has been carried out illustrates the increase in conformability of the fibres one to another, and the increase in fibrillar connection as a consequence of beating at the pulp stage.[10, 11, 15, 16] The differences in surface structure which result when the wet sheets are allowed to dry freely (that is, floating on mercury) compared with normal drying under a certain amount of restraint which prevents complete shrinkage have been illustrated.[11]

The striking differences to be observed between the wire and upper sides of a paper sheet have been underlined.[10, 13] The concentration of 'fines' (short fibres) and fillers is much lower on the wire side; as these particles are carried away with the water. These particular points are also amply demonstrated in the present work.

Other work[17, 19] has investigated the changes which occur in the web structure of paper on pressing and drying. The water was removed from the samples before observation by freeze-drying. Unpressed and lightly-pressed sheets show a very open structure with uncollapsed fibres, loose fibrils and limited areas of contact for bonding. As water is progressively removed at the various stages of paper sheet formation there is a progressive collapse of fibres, a compacting of the sheet structure and simultaneous identation of fibres by other fibres at fibre crossings.

Finally, the instrument has been used simply as a tool to observe what is happening to wood surfaces during investigations on its grinding zone temperature.[18]

Illustrations

We have so far a collection of 350 prints (and negatives). The ones chosen for reproduction now are those we feel particularly easy to understand by non-specialists and yet at the same time they illustrate the main lines along which our various research topics are proceeding.

1. Papers in general (illustrations 1–4)

a) Whatman no. 1, chromatography grade, cotton linters paper – the two sides of the paper are shown at the same magnification.

b) 'Permalife' paper composed of long, strong, well-purified chemical wood fibre specially prepared for high folding endurance and tear resistance. Sized with Aquapel and containing a small quantity of calcium carbonate. This type of paper was developed through the experimental work of the late W. J. Barrow under a grant provided by The Council on Library Resources Inc., Washington.

The most important point to be noted here is the extraordinary (but not unexpected) difference between the concentration of calcium carbonate particles on the two sides of the paper. Inevitably the question arises – what are the long term consequences of this? remembering that this is a paper primarily intended for permanent use, and devised to counteract aerial acidity.

c) Venetian 16th century rag paper, taken from a book damaged in the November 1966, Florence flooding (illustrations 5–8).

The interesting point here is that the dirtier side (easily visible with the naked eye) is the *wire side* of the paper, that is the side with the more open structure.

Whether more mud particles were retained on this side *because* of its more open weave, or whether this effect is solely the consequence of the *manner* in which the book was flood-damaged is impossible to say now. But it is interesting to note that when, for example, Whatman no. 1 paper is immersed in muddy-water there is a noticeable difference in the extent to which the two sides retain mud particles. This aspect of the problem is being investigated further.

2. Heat-set tissue (illustrations 9–16)

Heat-set tissue is the name given to a combination of lens tissue and a heat adhesive film which is used for repairing, in particular, the torn edges of book papers. An article on recent developments in its preparation will be appearing shortly. Difficulties encountered with the material in the past have arisen from the tendency of the adhesive film to penetrate through the upper surface of the lens tissue and thereby, under certain conditions, adhere to adjacent pages.

This tendency which has now been largely overcome was due to the inherent softness of the chosen resin film.

The scanning electron micrographs show the difference in the extent to

which two films, varying in hardness, penetrate through the lens tissue to its upper surface. The two heat-set tissues were applied to the same piece of Whatman no. 1 paper, and treated in precisely the same manner at the same time throughout.

3. Deacidification and buffering of paper (illustrations 17–28)

Unwanted acidity in aged paper is removed by neutralisation with calcium hydroxide solutions;[22] any excess hydroxide is rapidly converted to calcium carbonate in the air. Long term protection is conferred on the paper by treatment with calcium and magnesium bicarbonates in solution which in the air change into the carbonates.

Several aspects of this treatment are presently under investigation. The scanning electron micrographs are presented to draw attention to the sparse particle distributions (and hence surely protective capacity?) after treatment with some suggested solutions. As this is a problem now being tackled systematically no further comment is made now.

Interesting crystal formations produced during deacidification and buffering are also shown.

4. Green pigment damage on paper (illustrations 29–32)

This problem is again one currently under investigation, though from a different point of view from that taken by Bhowmik (q. v.).

The scanning electron micrographs show, all viewed from the same side of the paper, parts of a 16th century map where the painted areas are in an exceptionally friable state, while the paper of the rest of the map, both unpainted and painted in other colours, is relatively sound.

ACKNOWLEDGEMENTS

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ARRANGEMENT
OF PHOTOGRAPHS

1– 4	Papers in general
5– 8	Mud-dirtied paper
9–16	Heat-set tissue
17–28	Deacidification and buffering of paper
29–32	Green pigment damage on paper

PLATE 1

Whatman
no. 1
filter paper,
wire side,
× 248

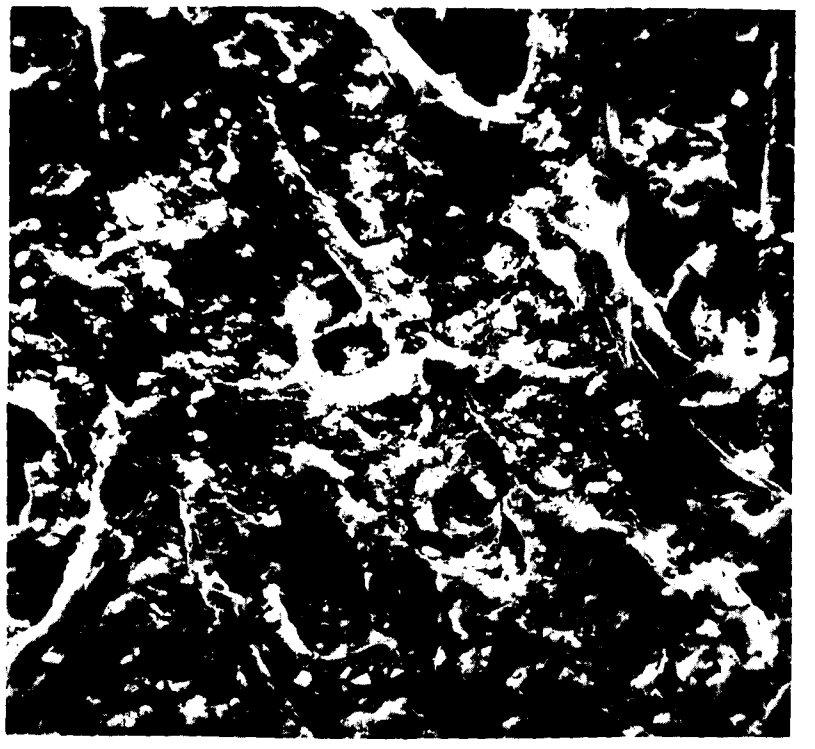
PLATE 2

Whatman
no. 1
filter paper,
upper side,
× 248

PLATE 3

»Permalife«
paper,
wire side,
× 248

PLATE 4



»Permalife«
paper,
upper side,
× 248

PLATE 5

Venetian
16th century
paper,
wire side
(*dirtier*),
× 560

PLATE 6

Venetian
16th century
paper,
wire side,
× 225

PLATE 7

Venetian
16th century
paper,
upper side,
× 560

PLATE 8

Venetian
16th century
paper,
upper side,
× 225

PLATE 9

Softer acrylic resin film on lens tissue, adhered to Whatman no. 1. Seen from lens tissue side, × 640

PLATE 10

The same, × 254

PLATE 11

Another area, × 640

PLATE 12

The same, × 254

PLATE 13

Harder acrylic resin film on lens tissue adhered to Whatman no. 1 paper. Seen from lens tissue side. × 640

PLATE 14

The same, × 254

PLATE 15

The same, another area, × 640

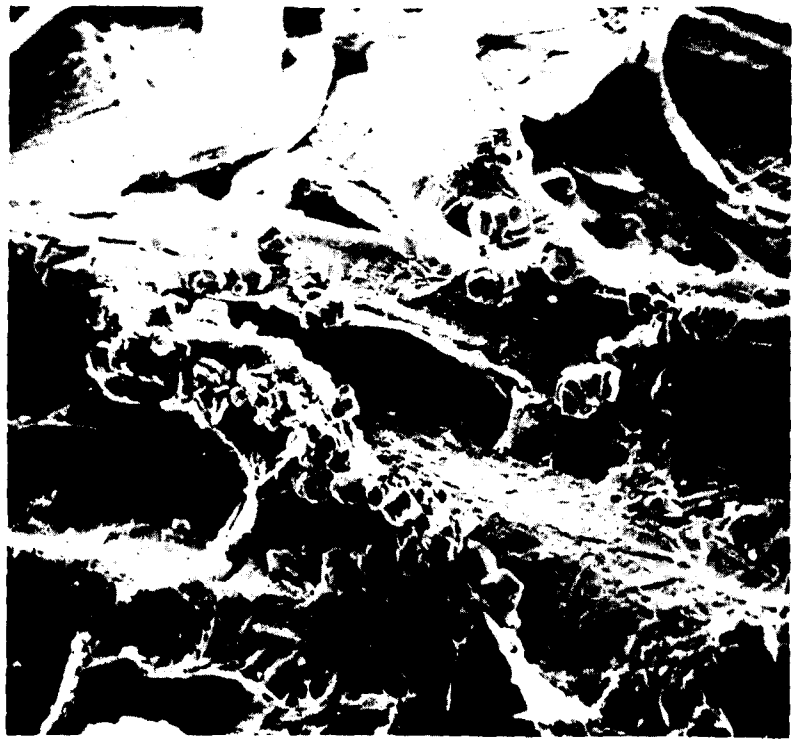
PLATE 16

The same, × 254

PLATE 17

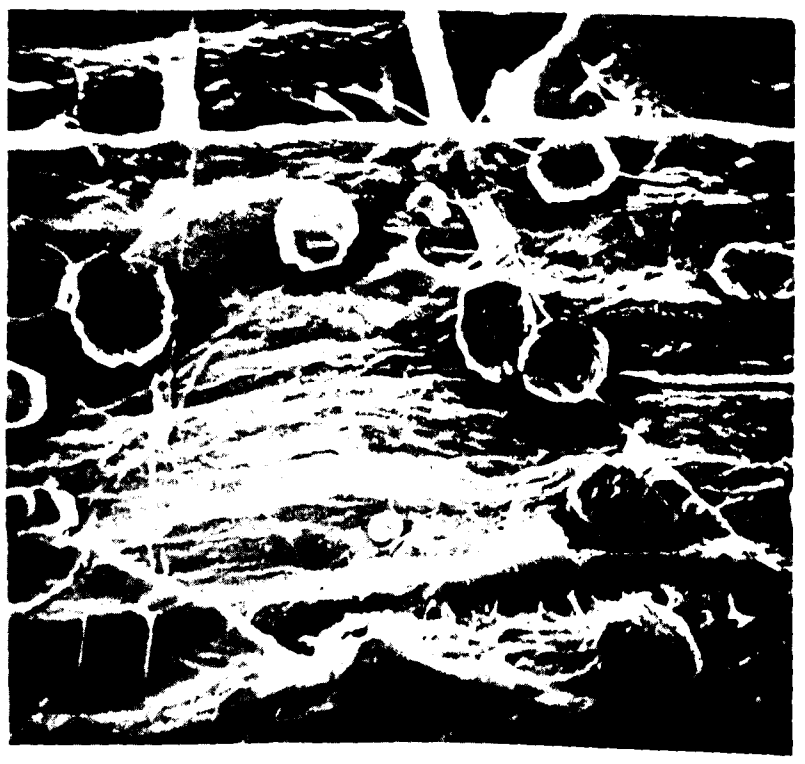
Paper immersed in calcium hydroxide solution then air-dried, × 2,200

PLATE 18



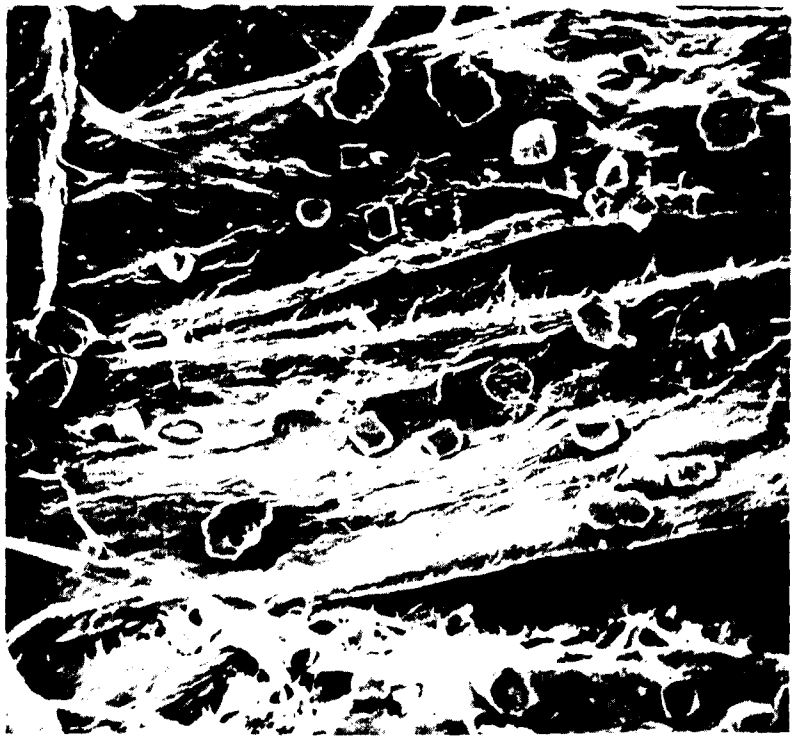
The same, × 1,100

PLATE 19



Reverse side of same paper after immersion in calcium hydroxide and air-drying, × 2,200

PLATE 20



The same, × 1,100

PLATE 21

The same type of paper after immersion in calcium hydroxide/ magnesium bicarbonate solution and air-drying, × 1,050

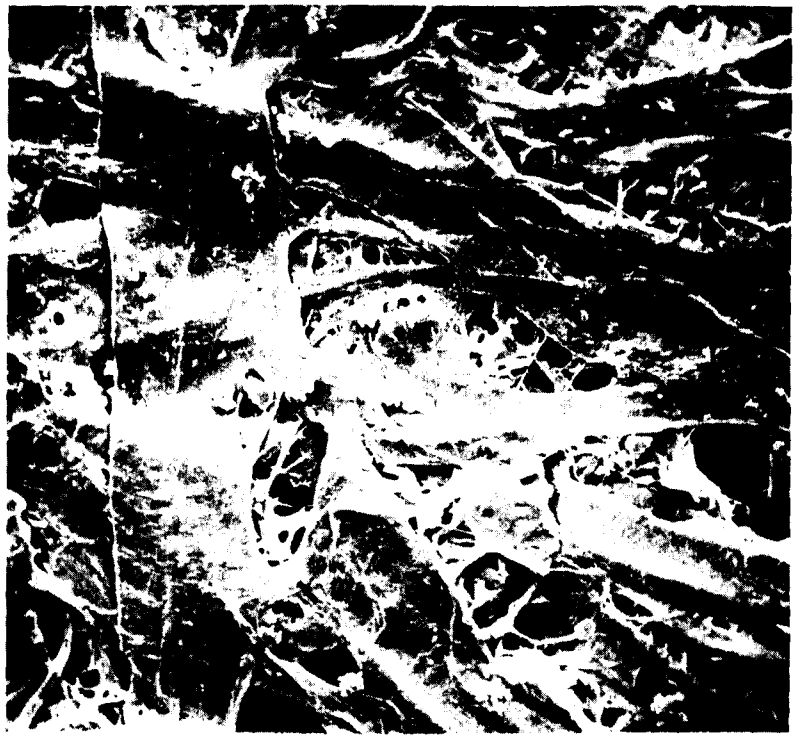
PLATE 22

The same, × 525

PLATE 23

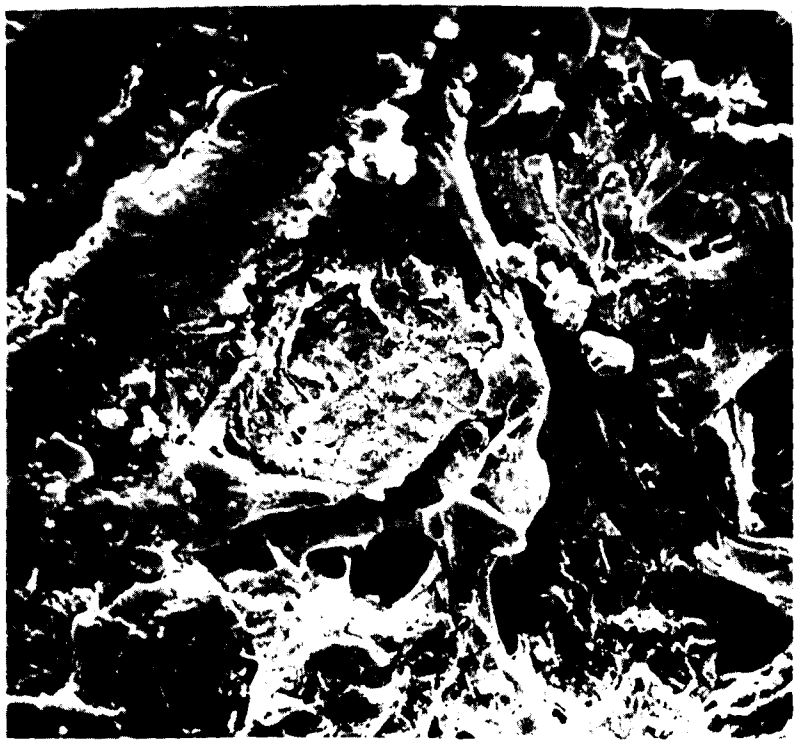
Reverse side of the same paper after treatment, × 1,050

PLATE 24



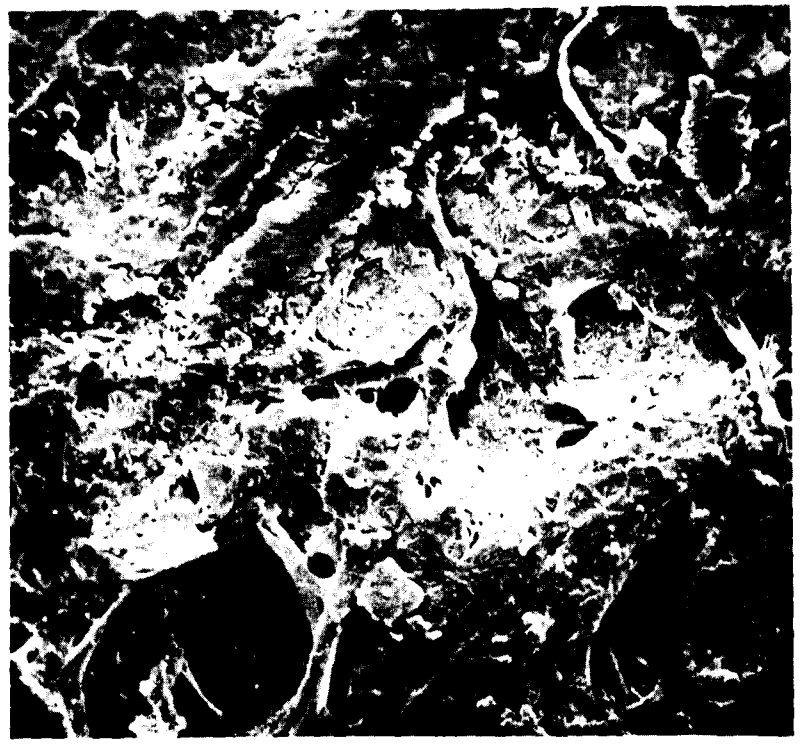
The same, × 525

PLATE 25



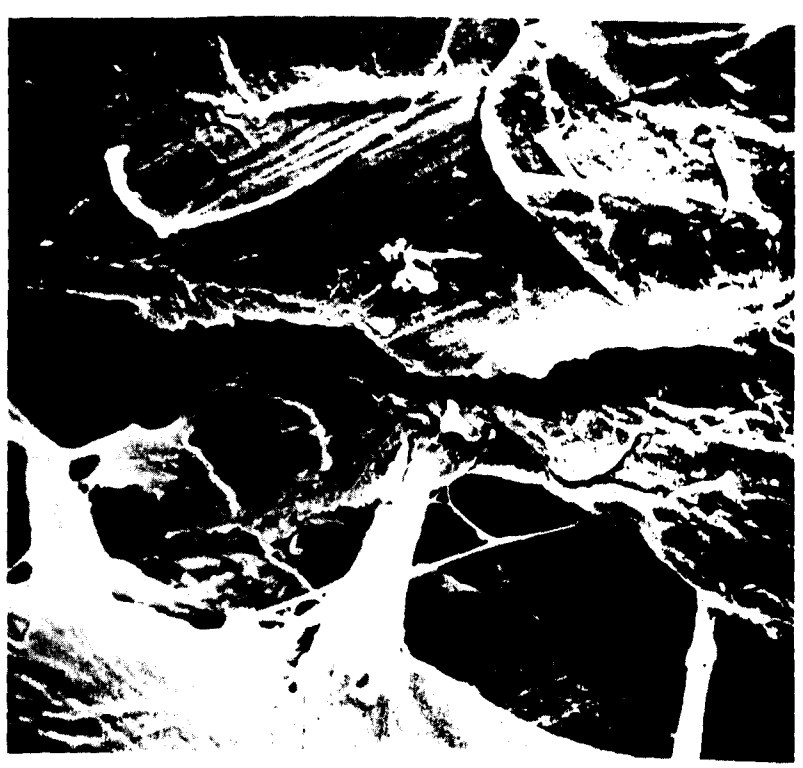
Same type of paper after immersion in barium hydroxide/methanol solution (24) and air-drying, × 2,100

PLATE 26



The same, × 1,050

PLATE 27

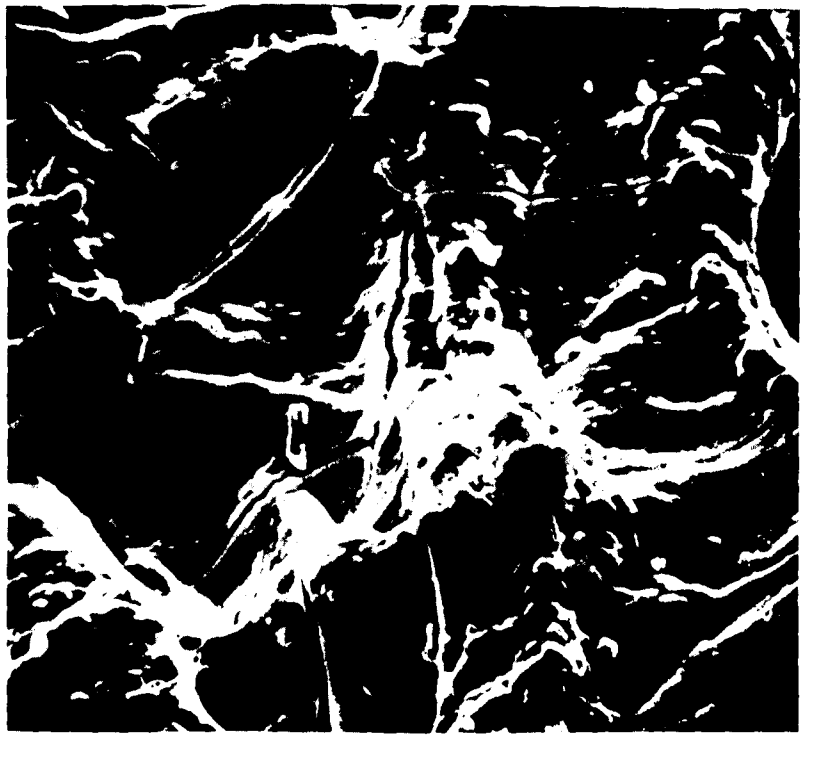


Reverse side of paper after the same treatment, × 2,100

PLATE 28

The same, × 1,050

PLATE 29

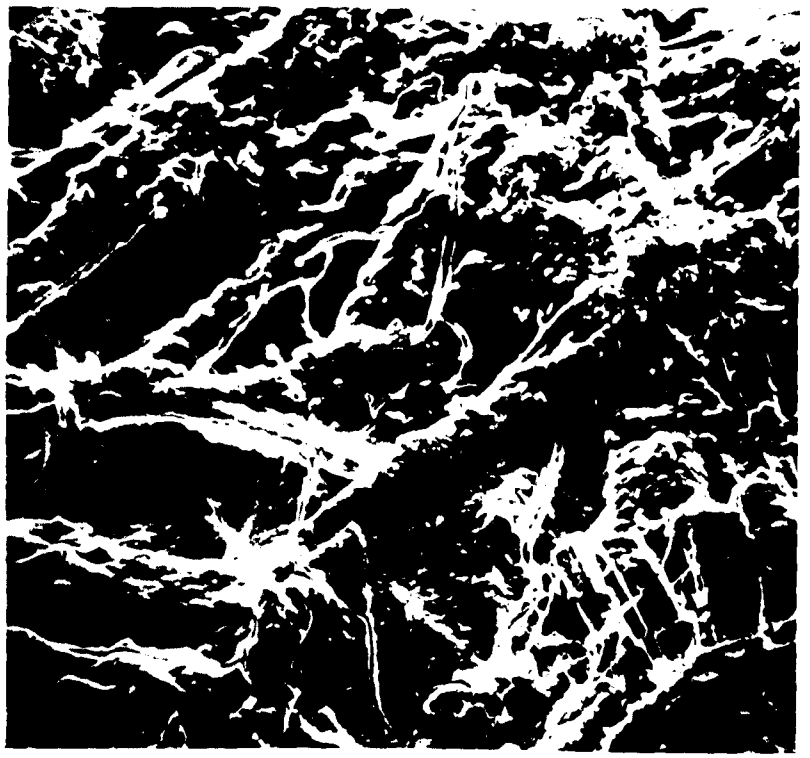


Reverse side of a green painted area on a 16th century map, × 1,200

PLATE 30

Same area, × 600

PLATE 31



Another area, × 600

PLATE 32

Reverse side of a pale blue painted area on the same map, × 600

SUMMARIES

The article describes the application of scanning electron microscopy to problems connected with document restoration. The advantages of this type of investigation over light optical and transmission electron microscopy are indicated. A brief description of the instrument's mode of operating is given together with details on sample preparation and photography.

The photographs illustrate the various restoration problems presently being investigated and attention is drawn to the more important features which have been revealed using this rather new technique.

Статья описывает применение растровой электронной микроскопии для задачи связанных с реставрацией документов.

Преимущества этого исследования над световой микроскопией и просвечивающей электронной микроскопией указаны. Краткое описание принципа действия растрового электронного микроскопа представлено вместе с деталями по приготовлении объектов и фотографировании.

Фотографии иллюстрируют сейчас испытанные различные проблемы реставрации, при чём внимание обращено к важнейшим особенностям, которые проявились при пользовании этой несколько новой методы.

Расположение фотографии

1–4 Бумаги.
5–8 Запачканная бумага.
9–16 Закреплённая шёлковая бумага.
17–28 Раскисление и буферное действие.
29–32 Повреждение зеленью.

Заголовки

1. Ватманская фильтровальная бумага № 1, нижняя (сеточная) сторона.
2. Ватманская фильтровальная бумага № 1, верхняя сторона.
3. »Permalife« долговечная («постоянная») бумага, нижняя (сеточная) сторона.
4. »Permalife« долговечная («постоянная») бумага, верхняя сторона.

5. Венецианская бумага с XVI века, нижняя (сеточная) сторона (грязная).
6. Венецианская бумага с XVI века, верхняя сторона.
7. Венецианская бумага с XVI века, верхняя сторона.
8. Венецианская бумага с XVI века, верхняя сторона.
9. Плёнка мягкой акриловой смолы на линзовой шёлковой бумаге приставной к Ватманской бумаге № 1; вид от стороны линзовой бумаги.
10. То же самое.
11. Другой край.
12. То же самое.
13. Плёнка жёсткой акриловой смолы на линзовой шёлковой бумаге приставной к Ватманской бумаге № 1; вид от стороны линзовой бумаги.
14. То же самое.
15. То же самое, другой край.
16. То же самое.
17. Бумага погружена в растворе гидрата окиси кальция.
18. То же самое.
19. Обратная сторона этой самой бумаги после погружении в растворе гидрата окиси кальция и воздушном сушении.
20. То же самое.
21. Бумага этого самого класса после погружении в растворе гидрата окиси кальция и бикарбоната магния и воздушном сушении.
22. То же самое.
23. Обратная сторона бумаги после обработке.
24. То же самое.
25. Бумага этого самого класса после погружении в растворе гидрата окиси бария и метанола и воздушном сушении.
26. То же самое.
27. Обратная сторона бумаги после этой самой обработке.
28. То же самое.
29. Обратная сторона позелённого района на карте с XVI века.
30. Этот самый район.
31. Другой край.
32. Эта самая карта, обратная сторона района покрашённого бледно-голубой краской.

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Margaret Hey
National Leathersellers' College
Tower Bridge Road
London, S. E. 1
Great Britain

Protein »Surgery«

A Restoring Procedure Applied on Paper

by Ø. WENDELBO & B. FOSSE

Protein surgery is an image used by the protein chemist to describe what he is doing when studying the complex structures of protein molecules. With an enzyme »scalpel« in hand he may cleave the molecule to its basic building stones and by that learn to know how the appearing protein is built.[1]

These enzymatic tools might be useful for restoring purposes too when the enzyme is carefully selected. Restorers in libraries and archives are often faced with the problem of opening documents, sealed by sudden water damage or by centuries' neglect of proper storage. All too often the restorers dare not try to open the documents in fear of damaging text and illustrations. Their methods are sometimes not good enough to avoid damaging the text or the procedures are so timeconsuming as to be prohibiting.

In this study the enzymatic approach has been tried on this problem, mainly on art paper from this century and on old paper from the late Gothic period. (Preliminary work on parchment has also been done with promising results which will be published later).

Left with a heap of valuable books, sealed by sudden water damage in 1967, efforts were made in 1970 to open them with convential methods, but in vain. The books most difficult to handle were those printed on art paper.

Feeling that modern chemistry should have an answer to this problem, experiments were set forth, testing three different chemical principles:

1. Substances lowering the surface tension of water. No useful effects for our purpose were observed.

2. Foamproducing solutions. In casu books soaked in hydrogen peroxide were exposed to solutions containing catalase. Some separation of the leaves was obtained by this method, but the paper became vulnerable because of the formation of gas bubbles in the individual leaves. Damages were done to text and illustrations when attempts were made to open the sealed pages.

Restaurator 1 · 1970 : 245–48

3. The enzymatic »scalpel«. Trypsin (crystalline) was chosen, as this enzyme hydrolyses peptides, amides, esters etc. at bonds involving the carboxyl group of argine and lysine.[2] Glue from collagen contains lysine,[3] so does casein.[4] The preliminary experiments gave excellent results: Complete separation without harm neither to text nor illustrations. This is still so, half a year later.

Crystalline trypsin is very expensive, and in our final experiments we decided to use a highly refined pancreatic extract, containing trypsin and chymotrypsin. Plate 1 shows the book chosen for the experiment. The printing was on art paper. The technical enzyme preparation had the activity of 3 Anson units/g; 100 grammes were used to 9 litres of aqua destillata, pH 7, tp. +25° C. The separation started almost at once and was complete within 10 minutes. The enzymatic effect was washed out by having the leaves pass a water bath (tap water). One third of the book was left in the enzyme solution 10 minutes longer than the other two thirds. In this part of the book slight traces of damage to the text and illustrations could be seen. For the rest the result was as good as when using crystalline trypsin. (See plate 2).

Our next experiment was to try to open a compact block of leaves (latin waste paper from the late Gothic period) see plate 3. The paper had been sized by bone glue, the leaves being inseparable because of the use of flour paste. A similar technical preparation of enzymes, but different in strength (6 Anson units/g) was now used. 10 grammes were solved in 3 litres of a phosphate buffer solution, pH 8,67, tp. +49° C.

Loosening started after 2–3 minutes and all the leaves, 10, were separated after 15 minutes. No damage to the paper nor to the text could be seen. The enzymatic effect was stopped by washing out in a water bath (tap water). Finally the paper had Barrows double shot:[5] (A) Calcium hydroxide solution (1½%) pH 12,56, room tp., and (B) Calcium carbonate solution (2%), pH 8,17, room temperature.

The result is seen in plate 4. The remnant of flour paste will be tried to remove by a carbohydrate splitting enzyme in a later experiment.

Acknowledgements

The authors are indebted to Professor, dr. philos. A. P. Nygaard and his staff, Department of Biochemistry, and Professor, dr. med. W. Harkmark and his staff, Department of Anatomy. Without their kind permission to use their laboratories, we would never have been able to carry out this study. We are also indebted to the firm, Novo Industri a/s, Copenhagen, Denmark, for kindly supporting us with the necessary enzymes.

Abstracts

The communication describes the use of enzymes in restoring of library and archival material. Successful experiments have been carried out by the use of proteolytic enzymes on documents (art paper, paper from the late Gothic period) sealed through water damage or by glue. Preliminary results on parchment by using the same opproach have been promising.

Descriptors: Enzymes-restoration, waterdamaged books, glued papers-parchment.

Сообщение описывает использование ферментов (энзимов) в реставрировании библиотечных и архивных материалов. С помощью ферментов расщепления протеин сделались удачные эксперименты на документах (бумагах для художественной печати, бумагах с поздноготического периода) склеившихся повреждением воды или клеем. Прелиминарные результаты экспериментов на пергаменте этой самой методой подают большие надежды.

Описание: ферменты (энзимы) – реставрация – книги поврежденные водой – склеенные бумаги – пергамент.

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4. *Ibid.* p. 44.
5. Plenderleith, H. J.: *The conservation of antiquities and works of art,* (p. 62). London: Oxford University Press 1956.

Ø. Wendelbo, M. D.
Faculty Librarian
University Library of Bergen
Bergen, Norway

B. Fosse
Technical Restaurator
State Public Record Office of Bergen
Bergen, Norway

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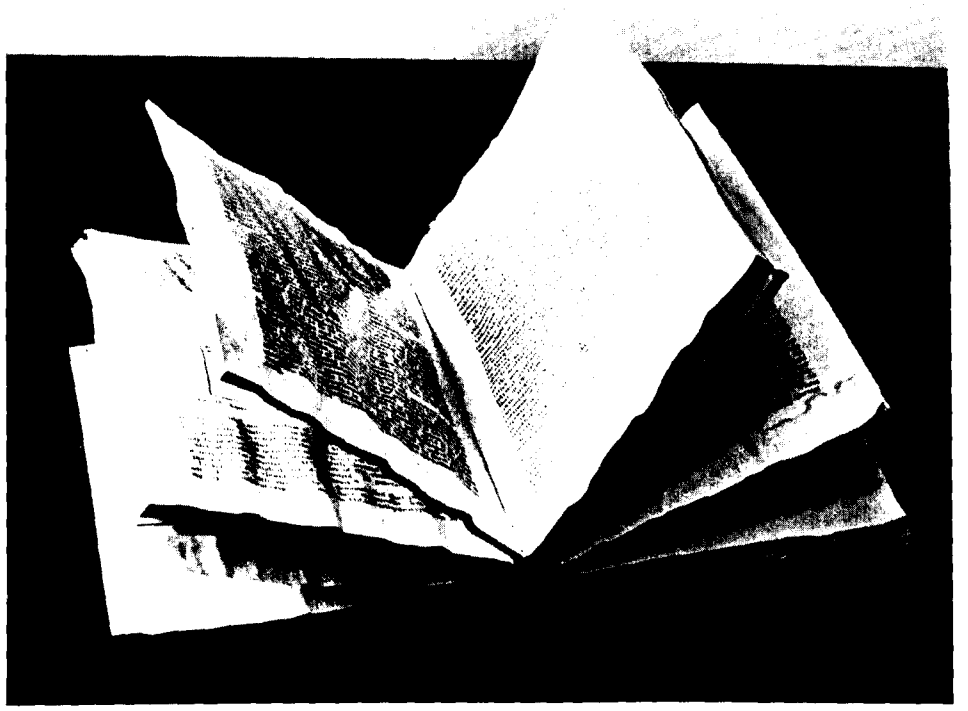


PLATE 1. The damaged book: Soffer, L. J., R. I. Dorfman and J. L. Gabrilove: The human adrenal gland. Philadelphia: Lea and Febiger 1961. 591 pp. ill.

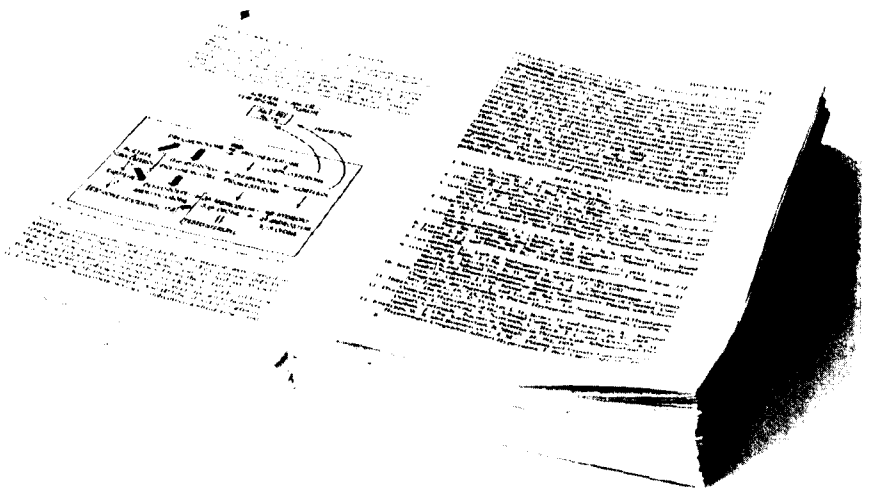


PLATE 2. The same book as shown in plate 1 after enzymatic separation of the leaves.

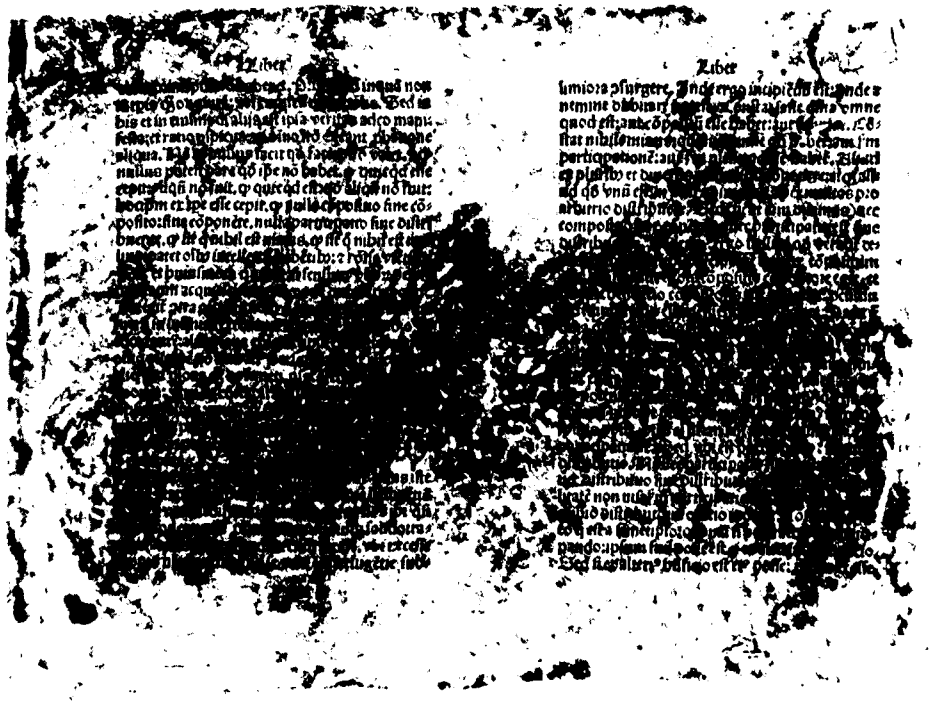


PLATE 3. Latin waste paper from late Gothic period. The block proved to contain 10 leaves.

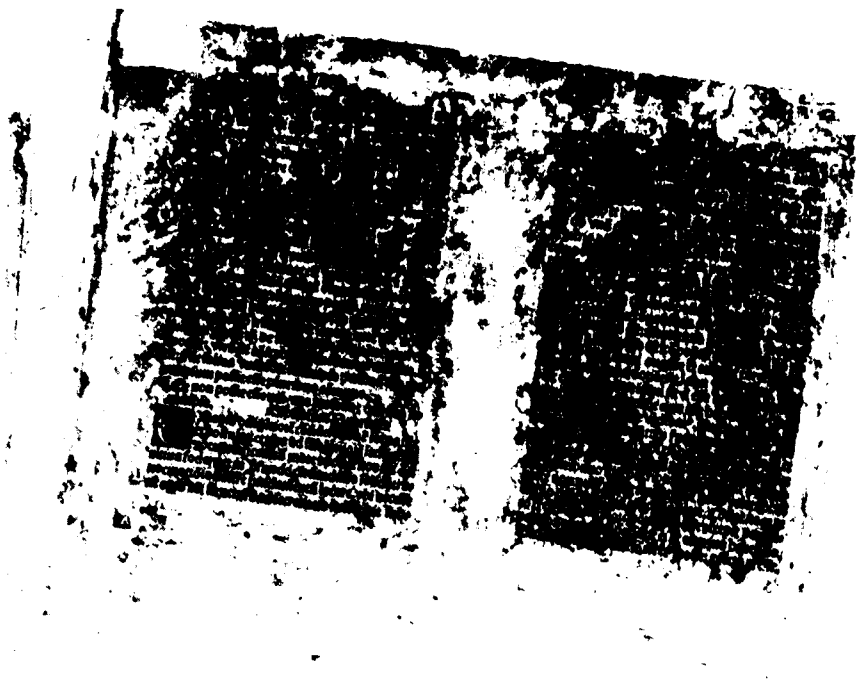


PLATE 4. The block shown in plate 3 after enzymatic separation of 10 leaves. Remnants of flour paste are still left.

Library of Congress Appoints Dr. John C. Williams to Direct Preservation Research and Testing Laboratory

The Librarian of Congress has announced the appointment of Dr. John C. Williams as Research Officer in the Office of the Assistant Director for Preservation, effective January 11, 1971. Dr. Williams comes to the Library from the Cuno Division of the American Machine and Foundry Co., Meriden, Conn., where he was Vice President in Charge of Research.

In his new position, Dr. Williams will establish and direct the work of the Preservation Research and Testing Laboratory, which will undertake both fundamental and applied research covering a wide range of preservation problems. The results of this research will be made available to the library and archival communities, and to others faced with an increasing number of problems in the preservation of their collections. The new research laboratory, which is being equipped with funds made available by the Council on Library Resources, is expected to be in full operation by May 1971.

A native of Oxford, Ohio, Dr. Williams attended both Miami University of Oxford and Oberlin College; he received his A. B. degree from Oberlin in 1931. He returned to Miami University for his M. A., which he received in 1933. In 1937, he earned his Ph. D. in chemistry from Iowa State University.

From 1938 until 1942, Dr. Williams was a research chemist with the Champion Paper and Fibre Co., where he was involved in a study of paper coatings, adhesives for paper coatings, and related problems. He was a fellow of the Mellon Institute of Industrial Research from 1942 to 1945, where he was involved in early work on the synthesis of polyester resins. From 1945 to 1962, Dr. Williams was Research Director of the Hawley Products Co., St. Charles, Ill., where he was engaged in research on paper sizings, adhesives, methods of adding resins to fibers in the beater, and special problems in the manufacture of paper and pulp moldings. He became Research Director and later Vice President for Research for the Cuno Division of AMF in 1962. While at Cuno, he directed research on water filtration problems and the design of cellulose cartridges for water pollution control.

Book Reviews

Microbiological Deterioration in the Tropics

Comprising papers (with discussions read at a Symposium organized by the Microbiology Group held on 8th and 9th April, 1965 at the London School of Hygiene and Tropical Medicine, London, W. C. 2. – Society of Chemical Industry Monograph no. 23. London: Society of Chemical Industry 1966. 262 pp. £ 3.5.0.

Reviewed by: A. D. Baynes-Cope
Principal Scientific Officer, M. A. B. Sc. F. R. I. C.
British Museum: Research Laboratory
London W. C. 1, Great Britain

This comparatively small book is one of the most sensible and interesting that the reviewer has read. The scientist concerned with library and archival conservation will find much to interest him directly in Miss Evan's paper: »*The Deterioration of Bookbinding Materials*«, but there is much material of immense importance in papers by Ayerst and Hueck and Butler & Eggins which can be used by the conservator to devise conditions in which damage will not occur. The library architect can profit from a study of papers by Whitely and by Skinner and O'Neill on the damage to paint films.

The fact that the symposium refers to tropical troubles should not deter the reader, neither should the fact that some papers refer to foodstuffs. A Polish participant points out that »tropical« conditions exist in hot human places, even in Polish coal-mines and the wise conservator must make sure that they do not exist anywhere in the library.

The discussions that followed each session are reported. There is no index, which is a pity, but the reviewer feels that the reader will learn so much in working through the book, that perhaps, on reflection, he will have gained in the long run!

The paper by a fellow called Baynes-Cope is a load of cod's wallop. It was a propaganda paper pure and simple, and no-one will learn much from it except that we have our problems!

Biodeterioration of Materials

Microbiological and Allied Aspects. Proceedings of the 1st International Biodeterioration Symposium, Southampton 9th–14th September, 1968.

Editors: A. Harry Walters and John J. Elphick. Amsterdam: Elsevier Publishing Co. Ltd. 1968. x + 740 pp. £ 12.10.0.

Reviewed by: A. D. Baynes-Cope
Principal Scientific Officer, M. A. B. Sc. F. R. I. C.
British Museum: Research Laboratory
London W. C. 1, Great Britain

Being the published version of the papers of a week-long symposium, without an account of the discussions and deliberately lacking an index, it is not entirely easy for specialists in the scientific aspects of library conservation to extract from this book the information that would interest them. The book is divided into twelve »Group Headings«, such as *»Mechanism of Biodeterioration«*, *»Ecological Aspects«* and each heading has about six papers. One might therefore think that what might be called »Library Conservators« would have some difficulty in finding out what interests them but this is only partly true. Any scientist worth his salt will find some point of interest in every paper and will find that a steady reading of this book will repay the effort made. Nevertheless, the search for information on any particular point may be prolonged.

The reviewer's experience in nearly twenty years of what might be called »Government Consultancy« work has convinced him that almost any question can be raised in a museum or library, regarding both the contents and the building and an understanding of the contents of this book will aid all those who have to answer such queries. Apart from what might be called the »specially important« articles by Hughes: *»Microbiological Deterioration in the Paper, Printing and Packaging Industries«* and Ayerst: *»Prevention of Biodeterioration by Control of Environmental Conditions«*, there are such articles as that by Kaplan: *»The Control of Biodeterioration by Fungicides-philosophy«*, which scientist, librarian and layman alike can read with profit, to gain an understanding of why choices are made, in practice, as to which fungicides are to be used for a specific purpose. The article by Orlita: *»Biodeterioration in the Leather Industry«* will give users of binding leathers some food for thought and the paper by Hueck et al.: *»Investigations on the Biological Activity of Pentachlorphenol Esters«* will interest those who use pentachlorphenol compounds on archival material. A careful study of the papers regarding timber and paint may make those responsible for choosing library shelving to be rather more careful in their specifications for the materials to be used.

Not withstanding the wide range of topics covered and the different

aspects of the topics covered, there are few if any papers that are too »technical« for the chemist to master and some papers are models of the art of instructing the layman.

In short, this is a book that all scientists concerned with library and archival material should obtain and a class of students of conservation seized on it with avidity. The pity is that the very high price would discourage individual purchase of a book that lacks an index.

B. L. Browning:
Analysis of paper. New York: Marcel Dekker, Inc. 1969. 342 pp. $ 18.75.

Reviewed by: William K. Wilson
Paper Evaluation Section
National Bureau of Standards
Washington, D. C. 20234
U. S. A.

This is a very useful reference on the analysis of paper and should be of service to laboratories that deal occasionally, or frequently, with paper. The broad range of subjects covered makes it especially useful as a general purpose source book.

The first chapter deals with paper as a commodity and gives background information that is of considerable interest to the analyst. The second chapter deals with the subject of sampling and preparation of samples. This subject is often overlooked. The other chapter headings include: Determination of Moisture, Fiber Analysis, Fiber Quality Methods, Lignin, Rosin Size, Starch, Proteins, Coatings, Waxes and Oils, Fillers and White Coating Pigments, Dyes and Colored Pigments, Acidity and Alkalinity, Residues and Impurities, Biological Control Agents, General Identification of Additives in Paper, Synthetic Resins, Wet-Strength Agents, Polysaccharides and Gums, Miscellaneous Additives, Non-cellulose Fibers, Specks and Spots, Permanence of Paper, and Paper in Forensic Science. The last two chapters, Permanence of Paper and Paper in Forensic Science, should be of special interests to document restorers.

In addition to a description of many types of analytical methods, considerable general information on the nature of paper is given. This type of information is indeed welcome, both to the expert and to the chemist who is inexperienced in the analysis of paper.

In most cases, methods are given in sufficient detail to enable the analyst

to make the determination without reference to other works. This is preferable for a book of this kind, as most analysts would not have the time to become familiar with all of the standard test methods for paper.

Some information usually is given concerning the significance of the tests. This is very important to the analyst who is inexperienced in the testing of paper.

The book is not designed to make a paper analyst out of a technician who is not trained in analytical techniques. It is necessary for one to have had training in quantitative analysis and preferably a degree in chemistry in order to adequately use this book. It is suitable for conservators who have had the proper analytical background.

The book contains 342 pages and includes a subject index and an author index. A random sampling indicates that the book is well indexed. The paper appears to be of good quality and the printing is of the proper size for easy reading. The length of the printed lines is 11 cm. This is short enough for rapid reading.

INTERNATIONALER RESTAURATORENTAG

Arbeitsgemeinschaft der Archiv-, Bibliotheks- und Graphikrestauratoren. Freiburg in Breisgau: I.A.D.A. Informationsstelle 1969. 191 pp. 13.50 DM.

Reviewed by: A. E. Werner, Keeper
British Museum: Research Laboratory
London W. C. 1
Great Britain

The conservation of graphic art and library and archival material poses many problems for those who are entrusted with the care of such collections. Many of the problems were discussed by practising restorers during a conference held in Freiburg in Breisgau, Basel and Zürich in September, 1967. The volume under review incorporates the proceedings of this conference, which took the form of lectures, demonstrations and discussions about the methods of conservation and restoration being practised in Germany, Switzerland, Austria and Denmark.

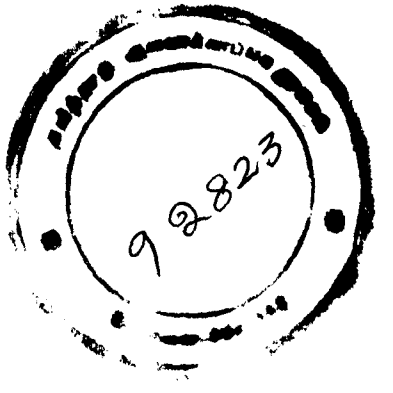
The topics under discussion covered a wide field; among the most important were the following: the restoration of parchment documents damaged by fire, the treatment of paper made from ground wood pulp, the fabrication of Japanese paper, methods for cleaning and repairing manuscript documents, the use of chloramine B and chlorine dioxide for

bleaching documents, the conservation of mediaeval wax seals, restoration of prints and drawings and an investigation into the deacidification of paper as carried out in Basel using formaldehyde and in Freiburg in Breisgau using amonia.

A particularly interesting and valuable feature of this book is the record of the discussions following each article. These are very informative because the advantages and disadvantages of the various conservation methods have been critically evaluated, and one obtains a good insight into the way in which difficult problems have been tackled by restorers who are conscious of the exacting nature of their work, and the need to proceed with caution. A few mistakes have found their way into the text which call for comment. Thus on page 39, in discussing the darkening of water colours, reference is made to sulphur dioxide converting lead white into black lead sulphite. This is quite wrong because lead sulphite is white; what is actually meant is the action of *hydrogen sulphide* converting lead white into lead sulphide, which is black. On page 89 reference is made to the conversion of the blue pigment, azurite, into green malachite by aerial oxidation, but this is incorrect, and on page 90 reference is made to the fact that lamination of parchment is carried out in the British Museum. The reviewer can state quite definitely that this is not the case.

The articles and discussion on bleaching methods are particularly good and it is stressed that, in the case of chlorinated bleaching agents, the important question is not *whether* they should be used, but *how* they should be used, and there is (on page 40) a warning about the danger of using chlorine bleaches on paper containing groundwood.

The editors of this book, Klaus Desbarats of Freiburg in Breisgau, Ludwig Ritterpusch of Marburg and Otto Wächter of Vienna, are to be congratulated on its production. It can be regarded as a most useful addition to the literature on the conservation of archival material and graphic art.



Erratum p. 31, table 3 last column:
For: Relative elongation in mm, *read:* Relative elongation in %.