

THE NEED FOR A RE-EVALUATION
OF THE USE OF ALUM IN
BOOK CONSERVATION AND THE BOOK ARTS.

By Tom Conroy*

I. The question of alum and its rejection.

For over three centuries alum was widely used in the making and repair of books. Since World War II its use for any purpose has become anathema to those who want their work to last. In the last few years, however, some of us have grown to feel that this total rejection was premature, almost phobic. Our discomfort comes from seeing that in some cases distinctive major damage to books is associated with high levels of alum; but that in other cases where the presence of alum would lead us to expect distinctive major damage it does not occur.

One clear pattern of damage is seen in high-quality machine-made alum-rosin sized book papers of the late 19th century: moderate overall browning and moderate to severe embrittlement. Alum-rosin size was identified as a likely cause of damage before World War I, and there is no other major likely cause in these papers¹. Early scientific studies of paper decay, done in Germany before the turn of the century, emphasized the rosin in the size, but by the 1920s work in Sweden and at the National Bureau of Standards had shifted the focus to alum². The excellent work of the NBS was interrupted by World War II, but from the late 1940s through the 1960s it was publicized and illegitimately extended by

1). I have in mind specifically the hard-sized, heavy, supercalendered papers fashionable in England and America in the 1880s and 1890s. Bleach may have added to the damage seen in these papers; but the dangers of bleach were seen and controlled in the early 19th century, and in any case bleach damage would not explain why cheaper slack-sized papers of this period sometimes remain strong when expensive hard-sized papers do not. Groundwood is an unlikely adulterant in these papers, especially in England where esparto was in common use, since groundwood would have made cheap-looking, not high-quality, papers; it may be noted, however, that in Germany groundwood came into use very early and very widely, which is probably one reason for the early German lead in the scientific study of paper deterioration (another reason was Germany's lead in chemistry in general before World War I).

2). Early research on paper deterioration is fascinating and instructive, but sadly it is far too little known. As an introduction see the abstracts, dating as far back as the 1880s, gathered by Walton (1929) and by Kantrowitz, Spencer and Simmons (1940). It is interesting to note that practices like starch sizing and heavy loading, banned for good reasons in permanence standards set at the turn of the century, are now allowed and even encouraged in "archival" papers; such practices will beyond doubt cause headaches for future conservators. Verner W. Clapp's frequently-cited "Story of Permanent/Durable Book Paper" should be approached with caution; it is a work of hagiography, not of history.

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William J. Barrow, whose ideas were set and rigid by the middle 1950s, before he did any laboratory research of his own³.

The belief that alum is bad for books was fixed by this pre-World War II research. All this research, however, looked at alum and rosin in papermaking, and particularly in machine papermaking. During the nineteenth century great amounts of aluminum sulfate were thrown into the pulp, not just to precipitate rosin but to control many running problems: alum was used to prevent slime formation, to prevent foaming, as a flocculant, and by habit to treat almost any other problem. Alum in the pulp has good access to bonding sites on the cellulose; and as the enormous load of water in new-made paper evaporates off it leaves behind a great deal of free alum. In brittle high-quality machine-made papers of the 1880s there is no reasonable doubt that the primary cause of damage is excess alum; the other components of the paper were sound. In a cheaper paper it is hard to say how much of its brittleness is caused by alum, how much by groundwood and other adulterants⁴; this is why I return to one class of high-grade papers for my example of damage caused by alum.

II. Reasons for questioning our knowledge of alum.

Although excess alum is clearly a major cause of damage in certain papers, this need not mean that it is highly destructive when used in binding or even in small quantities in papermaking. Alum does not cause perceptible problems in many uses; and in these uses it would not be thought of as a source of danger if it were not for the analogy from machine-made paper.

Books bound in traditional alum-tawed skins show little or no

3). Perhaps the most outrageous of Barrow's distortions of prior work was his equation of 25 years of natural age to 72 hours in a dry oven at 100° C., with his use of multiples of 72 hours to represent multiples of 25 years. This must have been based on ruler measurement of freehand lines in charts in one NBS study; yet this study, the only direct comparison of natural and accelerated aging available when Barrow introduced his equation, warned explicitly and repeatedly that the four data points on which the charts were based were insufficient for quantitative treatment. Later work has removed all credibility from Barrow's equation; yet it is apparently still used by some librarians and vendors. See: Barrow and Sproull (1959), especially p. 1079 and note 12 citing Wilson et. al. (1955); Wilson and Parks (1980); Bresee (1986).

4). Early research into paper deterioration was concerned with making permanent paper, not with preserving impermanent paper. Groundwood is so obvious and so serious a cause of decay that it was quickly rejected; more time and study were required to discredit alum/rosin. When the early research was applied to the preservation of unsound paper, this over-emphasis on alum/rosin was carried over, resulting in a paradoxical under-emphasis on groundwood. Much of the work that has been done on deacidification is permeated by the skewed balance of emphasis, and to my mind this undermines much of the rationale for across-the-board mass deacidification even to post-1850 papers. In this context, Leslie M. Kruth's recent remarks on varying attitudes toward deacidification are of interest. See Walton (1929); Kantrowitz et.al. (1940); Kruth (1988) p. 36.

browning or embrittlement of the pastedowns over the turn-ins, even after centuries of contact⁵. Tanned leather, of course, always attacks the turn-ins, which is a minor reason why conservators prefer tawed to tanned skins. Our attitudes at the bench are, in fact, inconsistent: we treat alum as our best friend in covering materials but as our worst enemy in paper and paste. This inconsistency alone should suggest that our knowledge of alum is faulty, and that more research is needed. We can guess why alum-tawed skins don't burn paper; but our guesses aren't backed up by knowledge.

Marbled papers a century old and older rarely show distinctive major damage linked to the alum used to fix their colors. Samples tipped into marbling texts give clearer evidence than endpapers or covering papers, since a sample's reverse side can be seen and its base paper judged⁶. If the alum from marbling were a major cause of damage then we would expect the sample itself always to be crisp, and the text block to be brown and brittle where, and only where, the sample touches it— in other words the sort of damage caused by a newspaper clipping left in a book for just a decade or two⁷. However, I have seen only one book where the paper of a marbled sample has altered the text block, and in this case the damage was no more than minor discoloration⁸. The colors used in marbling do often cause damage: the pigments and perhaps the ox gall create a ghost of the pattern on the facing text page or the reverse of the sample. Still, the slight damage sometimes caused by marbled paper centuries old is hardly enough to justify the fear with which it is sometimes regarded. The least we can conclude is that we should know more before rejecting

5). This form of damage is not completely unknown in books bound in tawed skins; but in historical examples (even from the 16th century) it is rare, and it is always mild by comparison to the browning adjacent to contemporary tanned leather. Some books bound in tawed skin in recent years already show serious burn over the turn-ins; but this is so unlike the historical pattern that I believe it due to some change in manufacturing— perhaps to the replacement of egg-yolk with modern fatliquors (a change which Hewit at least has made; see Barlee (1987) p. 19).

6). Sometimes made endpapers do go brittle. Newsprint was popular with marblers because marbling takes well on it; one reason for using made endpapers was to conceal the shoddy base paper of the marble. One must therefore consider the base paper before blaming damage on the alum used by the marbler.

7). The damage caused by bookmarks of various materials is a good rule-of-thumb indication of their aggressiveness, and should be noted when found while reading or examining.

8). This is the first (1856) edition of Nicholson's Manual of the Art of Bookbinding. In copies at the University of California in Berkeley and at Mills College in Oakland the exceptionally strong and white text paper is very slightly discolored adjacent to the tipped-in samples but not elsewhere— not even on the reverse sides of the discolored pages; both the text block and the samples remain supple and strong. There is also pattern ghosting from the colors in this edition. I have seen copies of later editions on inferior paper where the marbled samples had caused no noticeable damage.

marbling simply because it involves alum.

Even in papermaking the pattern of damage caused by alum is not completely uniform. Many slack-sized 19th-century alum/rosin papers retain completely adequate working strength: they can be used and rebound without undue damage. Most alum/gelatine (handmade) papers retain good to excellent working strength, even from the 18th century and earlier⁹; these papers, of course, were tubsized, not beater-sized, so the alum had poorer access to cellulose bonded to cellulose; and less water (thus less free alum) was left in the sheet after tub-sizing than after sheet formation. It is true that 16th century papers are often stronger than 18th century papers, and are also less likely to contain alum, but there need not be a causal connection: there are weak as well as strong 16th century papers, while 18th century paper was often weak when made. It is true that some 18th century books show copy-specific browning and embrittlement similar to that seen in hard-sized alum-rosin books; this is perhaps due to binders' washing and sizing recipes, in which at times more alum than gelatine was specified¹⁰. The evidence of damage is thus frequently contradictory or confusing, and there is no monolithic pattern of distinctive major damage associated with small and moderate amounts of alum in papermaking. If alum were as destructive as we are led to believe then we would expect to see such a pattern. The spotty and inconclusive evidence of damage is certainly no inducement to the use of alum; but its spottiness does suggest that we need to know more.

I can offer several guesses about why alum causes major damage in some cases but not in others. Perhaps the difference is simply quantity: if less alum causes less damage, and if the ratio is geometric, then a little less alum would cause a lot less damage. Perhaps aluminum sulfate (papermakers' alum, introduced in the 19th century) and potassium aluminum sulfate differ in the damage they cause¹¹; they haven't been distinguished in research on paper deterioration, possibly because in practice only aluminum sulfate is used in machine papermaking. Perhaps the state of alum in the sheet is critical: it may be bound to cellulose, bound to rosin, bound to gelatine, sitting in abrasive crystals in the sheet, or

9). Marjorie B. Cohn has drawn attention to the good condition of many 19th century handmade tubsized watercolor papers. See Wash and Gouache p. 21 and p. 74 note 52.

10). Anshelmus Faust (1612) p. 50-54, 115-17 gives 33% alum on gelatine size. Dudin (1772) p. 85-6 gives two recipes, one with 200% alum on gelatine, the other with 33% alum on gelatine and 3% gelatine on water. Arnett (1835) p. 199 gives 400% alum on gelatine and 3% gelatine on water; this absurd ratio is clearly due to a faulty mistranslation of Dudin's second recipe, but even so it may have been followed. Sizing often followed washing in alum-water, which helped to lift some stains.

11). "Alum" may refer to any of a class of salts. We know little about even the working differences between the two commonly used in making books, and nothing at all about whether they differ in permanence.

merely touching the surface. Perhaps the influence of iron and other impurities in low-grade alum has been underrated. The rosin in alum/rosin size might be looked at again, although one NBS study found low levels of rosin harmless or even preservative¹². All these guesses, however, are no more than potential lines of research. At the bottom, all we really know is that sometimes alum destroys paper—and sometimes it doesn't.

III. Reasons for resuming the study of alum.

It might be argued that further study is not needed even though we know little about the long- and short-term effects of alum on books: argued that alum is superfluous, that we can simply stop using it, and that for practical purposes this is good enough. Such an argument is false. For a few things alum cannot be done away with: in practice you cannot marble or taw without it. Where alum has been dispensed with it must either be replaced with other materials (whose effects are even less known) or else not replaced at all (which leaves the book subject to whatever ills the alum was meant to prevent).

To give up tawed skins or marbled paper would impoverish us: properly tawed skins in particular are, when available, thought to be the best of covering materials. Furthermore, all materials, every one of them, present some degree of risk. If we don't cover in tawed skin then we must cover in tanned leather, which is aggressive and impermanent; or in book-cloth slathered with soluble gun cotton (now normally called pyroxyline); or in starch-filled cloth, which grows tender with age and attracts bugs; or in vellum, which is often fragile or rigid and warps when the weather changes. If we reject tawing and marbling on the basis of theory plus the trivial damage observed, then there is no other material we can use without rejecting it on similar grounds.

Eliminating alum does not eliminate problems. Until the 1950s alum was always added to paste, partly to keep it from spoiling and going moldy before use. Some binders now prevent mold by adding formaldehyde, thymol, ortho-phenyl phenol, or other biocides. There is no reason to think these harmless to paper¹³, and there is good reason to think them harmful to bookbinders and other humans. To replace alum with substances whose long-term effects are even less known, for the sake of convenience,

12). See Shaw and O'Leary (1938). This very important study, on which Wilson and Parks' comparative study of 1980 was built, found that with some pulps 1% rosin seemed to improve the resistance of paper to heat-acceleration, and that 2% did even better (pp. 683, 685, Tables). However, the authors felt obliged to restrict this unexpected result to "pulp in the low stability range" (p. 689), and offered no speculations as to cause.

13). Rather the contrary: thymol-impregnated backing paper has been observed to yellow and disfigure framed and exhibited maps and prints. See Daniels and Boyd (1986) p. 156-8.

seems a distortion of priorities. It is no great chore to make paste once a week and throw it away when it spoils.

Newmade paper is also subject to mold while it dries; and the papermaker has no cure as easy as refrigeration or throwing spoiled paper away. If he does not use alum then he must have biocides in the sheet or sprayed in the drying loft. The load of water in newmade paper is many times that encountered by other book workers, even by conservators after washing; and mold in the papermill is a constant, expensive, unavoidable worry with no good solution¹⁴.

Alum was added to paste from at least the 18th century for another, more important, reason: it was used to discourage bookworm, particularly in paste applied to the spine¹⁵. This should be a special concern for those of us who paste the spine, either for guarding, as a release layer, or as the only adhesive, since nothing has been substituted for alum in this case. The implications of this old practice are broader than for single-book binding and repair. Nowadays in the temperate zone we worry little about bookworm because our great libraries and private collections suffer little from it. However, modern libraries are filled with books full of alum, a historical preservative against bookworm; and as early as 1880 it was noted that "they disdain to devour our adulterate modern papers"¹⁶. As the average paper quality in modern books improves, infestation may again become a major danger¹⁷, especially since alkaline papers sometimes use starch as a surface size. In any case, back to a narrower focus, I for one want to know if my paste is more attractive to insects because I don't put alum in it.

In gelatine-sized papers alum was added to keep the size bath from spoiling, to increase sizing effect, to alter some working properties,

14). In conservation a mold problem is either brought into the lab from outside or it is the result of carelessness. I once assumed that as far as mold prevention goes, both alum and biocides could be avoided with care and refrigeration. More recent and closer contact with papermakers has disabused me.

15). See Dudin (1772) p. 32, and Gauffecourt (1763) p. 38, 100. Arnett (1835) p. 201 mentions both alum and vitriol (sulfuric acid!) to destroy bookworms--- a useful reminder that old recipes should be used with caution.

16). The phrase is Andrew Lang's (1881) p. 40, citing William Blades' The Enemies of Books (1880) p. 62, 83-4 in the 1902 edition. The adulterants which Blades had in mind were bleaches and fillers; he does not mention alum (or, for that matter, groundwood), and he may have been unaware of its use in papermaking.

17). Sally Buchanan has noted the destruction of acid-free book flaps by silverfish which did not attack the books themselves (Abbey Newsletter 1984; personal communication). I do not wish to blow things out of proportion; it is obviously better to have books that may be eaten by insects than books that will be destroyed by internal vice. But if alkaline paper is more subject to insect attack, then now is the time to consider the problem.

and perhaps to harden the size¹⁸. It would also help control mold in the drying loft and might give some residual mold-resistance to the finished sheet. While some conservators and hand papermakers strongly favor synthetic sizes¹⁹, others distrust or are disenchanted with them, either because their aesthetic and mechanical properties differ from the traditional, because their working properties are less desirable, or because they are not yet sufficiently tested by natural aging. It may be, however, that some of the properties sought in gelatine size are there only when alum is added²⁰. If so, one conservator who liked gelatine might decide that on the whole synthetics were preferable; another, that the risks of alum were small enough to discount; and a third, that gelatine without alum was the best compromise. The alternatives are closely balanced, as is shown by the lack of uniform opinion among conservators²¹; we need to know more about the effects of alum on gelatine size if we are to make wise choices in resizing or in the choice of new repair papers²².

IV. Conclusion.

Once we start to ask questions about alum we soon see that we have

18). There seems to be a curious vagueness about just what changes alum made in the working properties of gelatine size. Small amounts of alum are used to thicken the size, but larger amounts reduce viscosity; see Paper Conservation Catalog section 17.2.4.A.1.c. Hot glue, a concentrated crude gelatine, will foam if alkaline, and alum was added to glue to prevent this (ibid.); but I have had no trouble in coping with foaming in the dilute solutions used for sizing. Alum was used to harden photographic emulsions, and is sometimes said to have been used to "harden" size as well as increase the sizing effect; but I have been unable to understand what a "harder" size would be unless increase in sizing effect itself is meant. I have been told that alum kept wet paper from blocking when excess gelatine size was squeezed out in a press, as was done in traditional sizing technique; but I have been unable to document this effect.

19). Papermakers prefer cellulose reactive internal sizes like Aquapel and Hercon-40 because they reduce double handling and wet time; users dislike them because they make it hard to relax paper by wetting it out, and because if the size is unevenly distributed then ink will not take in some parts of the sheet but will feather in others. Conservators when resizing prefer cellulose ethers like methyl cellulose (ibid. 17.6.1); in papermaking these would share the drawbacks of gelatine. I have noticed that this difference in preference and expectation can cause confusion in conversation. Both classes of synthetic size share the advantages that they are bioresistant and can be used cold; but both add much less strength to paper than does gelatine.

20). The possible residual bioresistance of alum is critical, since bioresistance is often the basis of preference for a synthetic size. This is not a property traditionally claimed for alum; but it would not be noticed separately when all gelatine was used with alum. Alum may also crosslink gelatine, altering strength, stability, and reversability and making a sort of "alum-tawed gelatine." The possibility of unknown effects, both good and bad, should be remembered.

21). See Paper Conservation Catalog 17.6.1, citing Garlick (1986) and Henry (1986).

22). Two other uses of alum should be mentioned, although I know too little about either to comment; it was used as a hardener in photographic emulsions; and it was used to eradicate some stains when washing books (as were stronger acids like hydrochloric).

little solid knowledge about why it was used in many cases, or if it did what it was supposed to do, or how much is needed to do what is wanted, or what unnoticed and unintended good and bad things it did, or generally of its real effects on working properties and permanence. There has been little scientific research on many of the points I have raised here, and none on some of them. My generation of binders and hand papermakers was taught not to use alum, so we lack even the rule-of-thumb knowledge of its working properties which our elders have. We are left with the paradox of alum touted as our worst enemy in paste and paper but our best friend in leather; the paradox of banning it in papermaking because we see the damage it causes and then having to ban it in marbling because it may cause damage no one has seen or felt or measured.

The purpose of this paper has been to point to blocks of ignorance. It is a call for research, not a report of research. Many of my examples are drawn from the unformulated and unrecorded body of observations which any thinking book worker will have gathered, but which will differ a little for each of us. When scientific research is successful it will illuminate these broader, but less rigorous, informal observations; but when the theories deduced stubbornly refuse to match certain observations then research must be repeated and theory corrected. It is my contention, indeed, that in the matter of alum the time may be here for what Thomas S. Kuhn has called a change of paradigm.

I do not wish to suggest that we resume the indiscriminate use of alum as hastily as we abandoned it. It is, as I have said, undoubtedly destructive in some uses. But I think that for the present there is no need to agonize over its remaining uses; and that binders using alum-tawed skins, marblers using alum with ox gall, and even hand papermakers using alum in gelatine size may at their judgement continue to use a substance which their predecessors used for centuries without causing significant perceptible damage.

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