Research for the Archivist of Today and Tomorrow

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THE problems involved in preserving historical documents are well known to the readers of this magazine. The paper on which these documents are printed may be described under two general classes with gradations all the way from one to the other. Papers may be classified as "permanent," meaning, historically, that they have been made from rags under such conditions as would give them long life, and "not permanent," meaning almost everything else; for it has been ordinarily considered that paper made from either chemical or mechanical wood pulp and from straw will have a shorter life span than will the well made rag papers.

Actually, the life expectancy of a sheet depends on the conditions of papermaking and conversion, as well as on the original fiber furnish. High acidity in the sheet, high rosin content, high acidity in the inks, all combine to shorten the life expectancy even of the so-called permanent papers. The presence of alkaline buffering agents neutralizes the effect of the acid and lengthens the period of service. Proper observance of the fundamental knowledge in the field may give even the so-called nonpermanent wood pulp and straw papers much longer than normal "life expectancy." In addition, modern pulp making and refining techniques have produced wood pulps of high purity and greatly improved potential service. Today, therefore, we want to know not only the fiber furnish but also the character of the sheet before we pass judgment on its probable behavior over the years.

Unfortunately, the printer, more often than not, has no idea of the future value of the job he is printing. Handbills have been put on the cheapest paper — municipal records on whatever was available in the print shop.

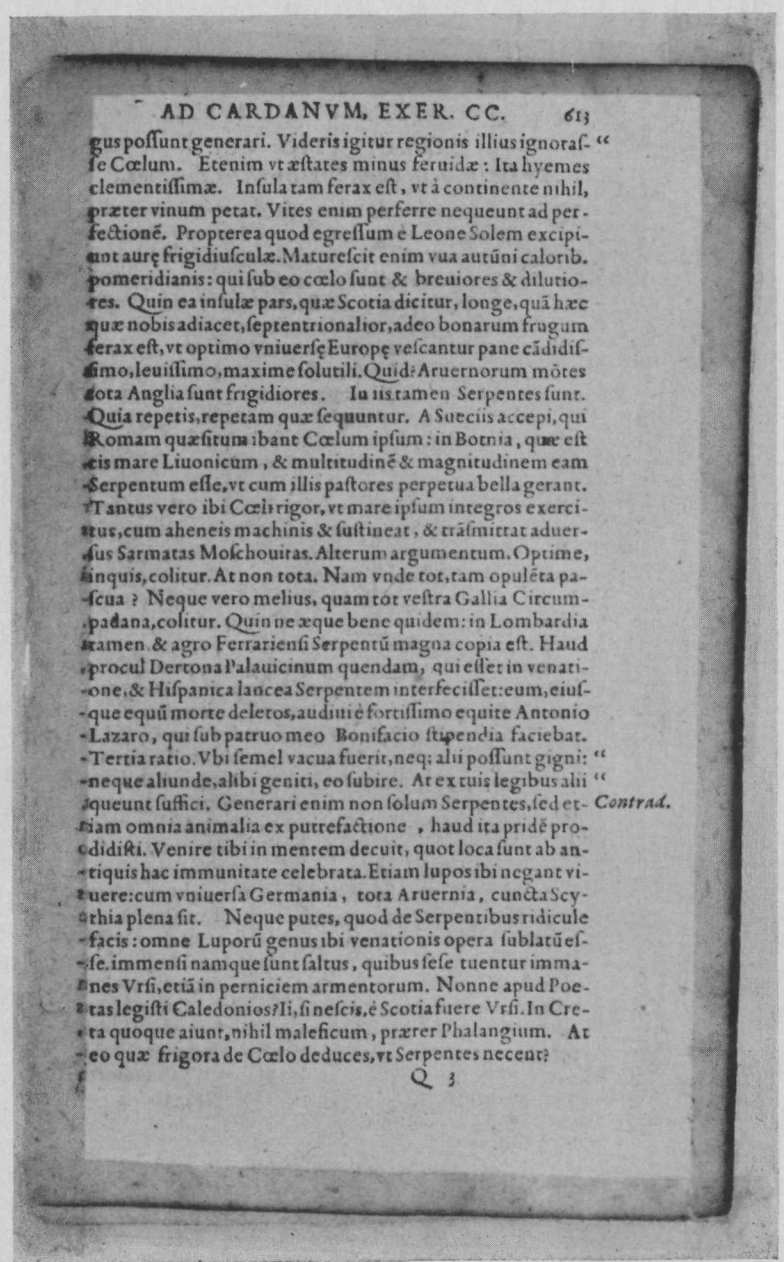
By happy circumstance, the only paper available in quantity to the printer before the middle of the last century was made from rags by a process which providentially yielded a first-class product.

The combination of lime and soft water and the absence of chemical bleaching agents gave a product which usually was left with a residue of lime to serve as an acid-controlling buffer; the further process for making the paper added little to harm the sheet. Later, processes were developed for making wood pulp, and the residues of cooking chemical and bleaching chemical left in the pulp (and paper), together with the growing habit of the papermaker to use alum freely as a cure-all for papermaking problems, resulted in the manufacture of paper from good wood cellulose which was ill fitted to stand exposure to sunlight, heat, humidity, or the self-degradation brought about by the undesirable residues added at one stage or another in the process.

How to preserve this heterogeneous collection of material has been and still is a problem. If the document itself is priceless to the collector by virtue of its historical association, it may be preserved by facing on both sides with cellulose acetate foil and then applying heat and pressure. This seals the document against the harmful gases in the atmosphere without the use of an adhesive. Other treatments are available for handling specific problems, but it is not the purpose of this paper to review them. The interested reader is referred to the report on this subject from the U. S. Bureau of the Census [Kimberly, Arthur E. U. S. Bureau of the Census. Vital Statistics. Special Reports 3, No. 33:153-60 (August 5, 1937)]. Where the contents of the document are more important than the document and particularly where it will be used for reference, we have available the photographic process using either microfilm, film slides, or photostats. Beyond that, rather fantastic devices have been suggested as means of preserving materials for "all time," such as scratchings on glass, markings on porcelain, or the Digby process of printing with platinum on thin gold foil. The justification for resorting to such means as these must be left to those others who are better qualified to judge.

This paper, however, is not directed to how documents may be preserved. It is intended to point toward the researches which have been set up to study the actual reactions involved in the aging of paper and the conditions which initiate and accelerate such reactions. Research of this type is forward looking — it deals more particularly with the preservation of future documents rather than with those which became historically important during some past generation.

The preservation of records made on high-grade papers is relatively simple. Paper meeting the specifications for "permanent



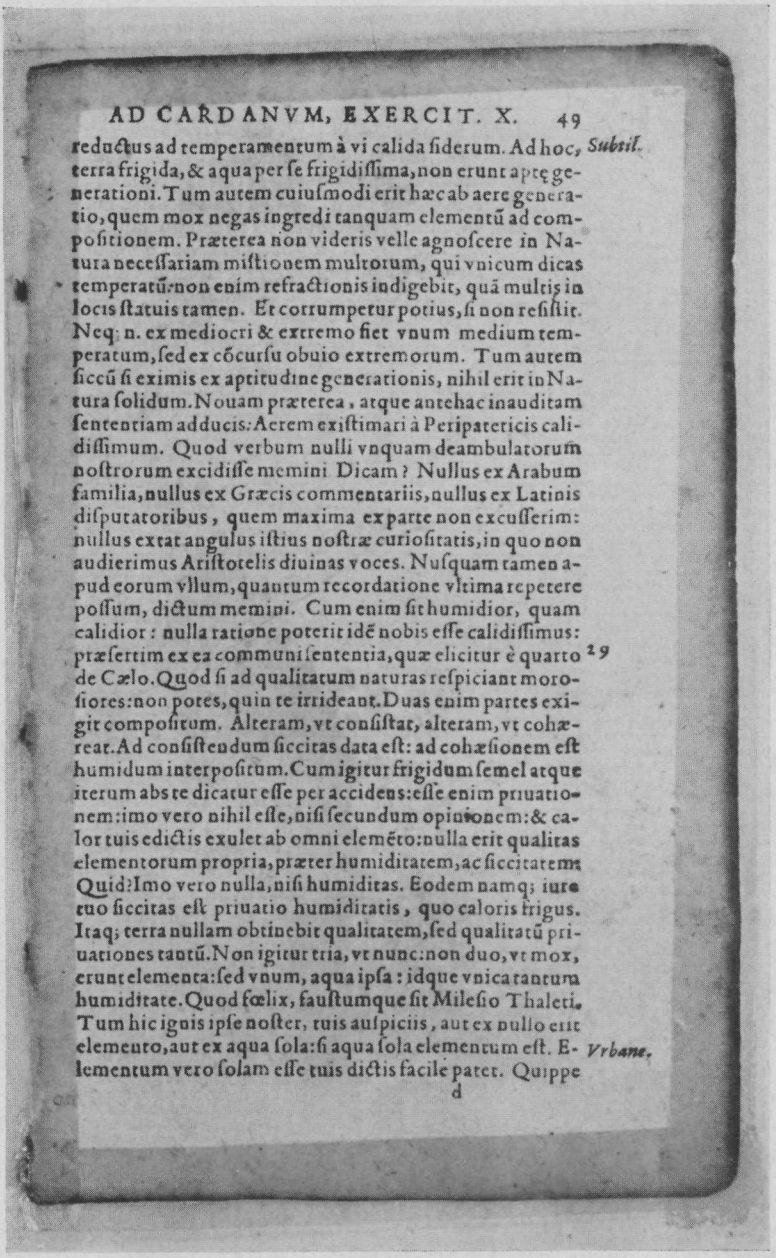
AD CARDANVM, EXER. CC. 613

gus possunt generari. Videris igitur regionis illius ignoras- "
se Cœlum. Etenim vt æstates minus feruidæ: Ita hyemes
clementissimæ. Insula tam ferax est, vt à continente nihil,
præter vinum petat. Vites enim perferre nequeunt ad per-
fectionẽ. Propterea quod egressum è Leone Solem excipi-
unt aurę frigidiusculæ. Matureſcit enim vua autũni calorib.
pomeridianis: qui sub eo cœlo sunt & breuiores & dilutio-
res. Quin ea insulæ pars, quæ Scotia dicitur, longe, quã hæc
quæ nobis adiacet, septentrionalior, adeo bonarum frugum
ferax est, vt optimo vniuersę Europę vescantur pane cãdidis-
simo, leuissimo, maxime solutili. Quid? Aruernorum mõtes
tota Anglia sunt frigidiores. Iu iis tamen Serpentes sunt.
Quia repetis, repetam quæ sequuntur. A Sueciis accepi, qui
Romam quæsitum ibant Cœlum ipsum: in Botnia, quæ est
eis mare Liuonicum, & multitudinẽ & magnitudinem eam
Serpentum esse, vt cum illis pastores perpetua bella gerant.
Tantus vero ibi Cœli rigor, vt mare ipsum integros exerci-
tus, cum aheneis machinis & sustineat, & trãsmittat aduer-
sus Sarmatas Moschouitas. Alterum argumentum. Optime,
inquis, colitur. At non tota. Nam vnde tot, tam opulẽta pa-
scua? Neque vero melius, quam tot vestra Gallia Circum-
padana, colitur. Quin ne æque bene quidem: in Lombardia
tamen & agro Ferrariensi Serpentũ magna copia est. Haud
procul Dertona Palauicinum quendam, qui esset in venati-
one, & Hispanica lancea Serpentem interfecisset: eum, eius-
que equũ morte deletos, audiui è fortissimo equite Antonio
Lazaro, qui sub patruo meo Bonifacio stipendia faciebat.
Tertia ratio. Vbi semel vacua fuerit, neq; alii possunt gigni: "
neque aliunde, alibi geniti, eo subire. At ex tuis legibus alii "
queunt suffici. Generari enim non solum Serpentes, sed et- *Contrad.*
iam omnia animalia ex putrefactione, haud ita pridẽ pro-
didisti. Venire tibi in mentem decuit, quot loca sunt ab an-
tiquis hac immunitate celebrata. Etiam lupos ibi negant vi-
uere: cum vniuersa Germania, tota Aruernia, cuncta Scy-
thia plena sit. Neque putes, quod de Serpentibus ridicule
facis: omne Luporũ genus ibi venationis opera sublatũ es-
se. immensi namque sunt saltus, quibus sese tuentur imma-
nes Vrsi, etiã in perniciem armentorum. Nonne apud Poe-
tas legisti Caledonios? Ii, si nescis, è Scotia fuere Vrsi. In Cre-
ta quoque aiunt, nihil maleficum, præter Phalangium. At
eo quæ frigora de Cœlo deduces, vt Serpentes necent?

Figure 1

Class A sheet

CALCIUM CARBONATE — 2.10%



AD CARDANVM, EXERCIT. X. 49

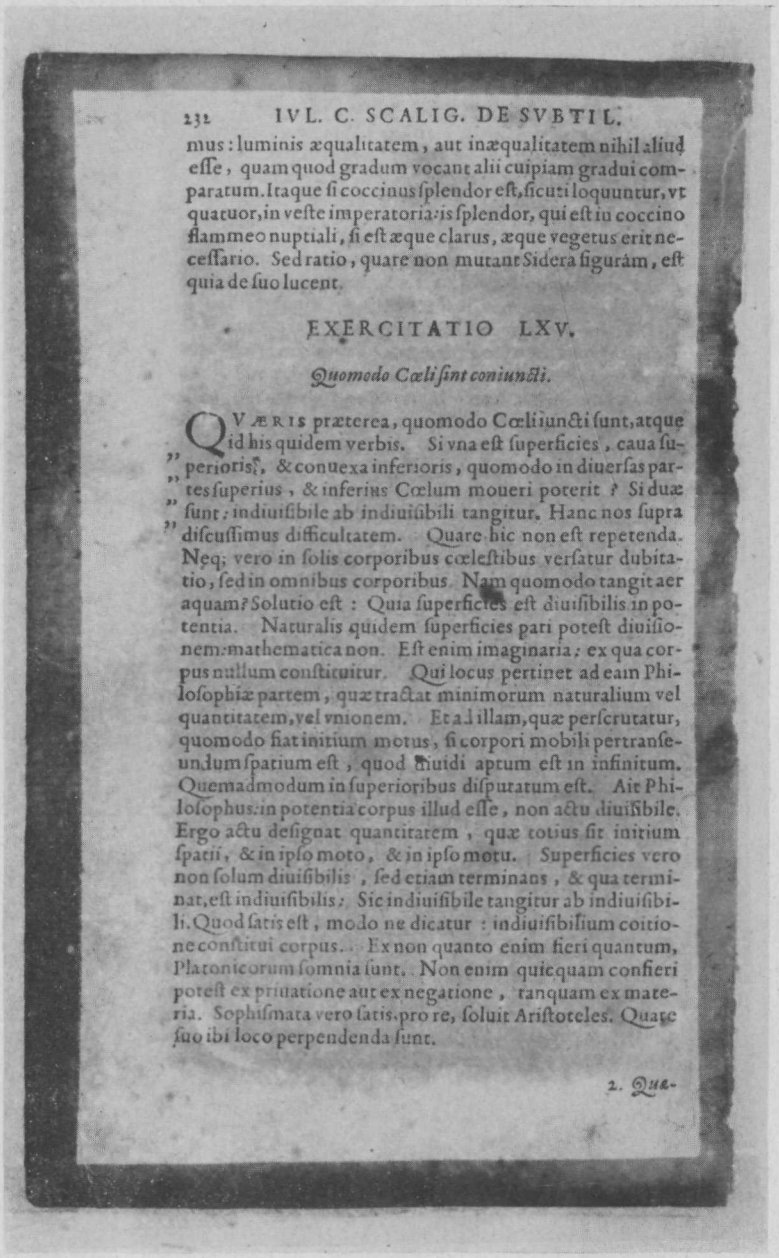
reductus ad temperamentum à vi calida ſiderum. Ad hoc, *Subtil.*
terra frigida, & aqua per ſe frigidiſſima, non erunt aptę generationi. Tum autem cuiuſmodi erit hæc ab aere generatio, quem mox negas ingredi tanquam elementũ ad compoſitionem. Præterea non videris velle agnoſcere in Natura neceſſariam miſtionem multorum, qui vnicum dicas temperatũ: non enim refractionis indigebit, quã multis in locis ſtatuis tamen. Et corrumpetur potius, ſi non reſiſtit. Neq; n. ex mediocri & extremo fiet vnum medium temperatum, ſed ex cõcurſu obuio extremorum. Tum autem ſiccũ ſi eximis ex aptitudine generationis, nihil erit in Natura ſolidum. Nouam præterea, atque antehac inauditam ſententiam adducis: Aerem exiſtimari à Peripateticis calidiſſimum. Quod verbum nulli vnquam deambulatorum noſtrorum excidiſſe memini Dicam? Nullus ex Arabum familia, nullus ex Græcis commentariis, nullus ex Latinis diſputatoribus, quem maxima ex parte non excuſſerim: nullus extat angulus iſtius noſtræ curioſitatis, in quo non audierimus Ariſtotelis diuinas voces. Nuſquam tamen apud eorum vllum, quantum recordatione vltima repetere poſſum, dictum memini. Cum enim ſit humidior, quam calidior: nulla ratione poterit idẽ nobis eſſe calidiſſimus: præſertim ex ea communi ſententia, quæ elicitur è quarto 29
de Cælo. Quod ſi ad qualitatum naturas reſpiciant moroſiores: non potes, quin te irrideant. Duas enim partes exigit compoſitum. Alteram, vt conſiſtat, alteram, vt cohæreat. Ad conſiſtendum ſiccitas data eſt: ad cohæſionem eſt humidum interpoſitum. Cum igitur frigidum ſemel atque iterum abs te dicatur eſſe per accidens: eſſe enim priuationem: imo vero nihil eſſe, niſi ſecundum opinionem: & calor tuis edictis exulet ab omni elemẽto: nulla erit qualitas elementorum propria, præter humiditatem, ac ſiccitatem. Quid? Imo vero nulla, niſi humiditas. Eodem namq; iure tuo ſiccitas eſt priuatio humiditatis, quo caloris frigus. Itaq; terra nullam obtinebit qualitatem, ſed qualitatũ priuationes tantũ. Non igitur tria, vt nunc: non duo, vt mox, erunt elementa: ſed vnum, aqua ipſa: idque vnica tantum humiditate. Quod fœlix, fauſtumque ſit Mileſio Thaleti. Tum hic ignis ipſe noſter, tuis auſpiciis, aut ex nullo erit elemento, aut ex aqua ſola: ſi aqua ſola elementum eſt. E- *Vrbane.*
lementum vero ſolam eſſe tuis dictis facile patet. Quippe

d

Figure 2

Class B sheet

Calcium Carbonate — 1.62%



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mus: luminis æqualitatem, aut inæqualitatem nihil aliud esse, quam quod gradum vocant alii cuipiam gradui comparatum. Itaque si coccinus splendor est, sicuti loquuntur, vt quatuor, in veste imperatoria: is splendor, qui est in coccino flammeo nuptiali, si est æque clarus, æque vegetus erit necessario. Sed ratio, quare non mutant Sidera figuram, est quia de suo lucent.

EXERCITATIO LXV.

Quomodo Cœli sint coniuncti.

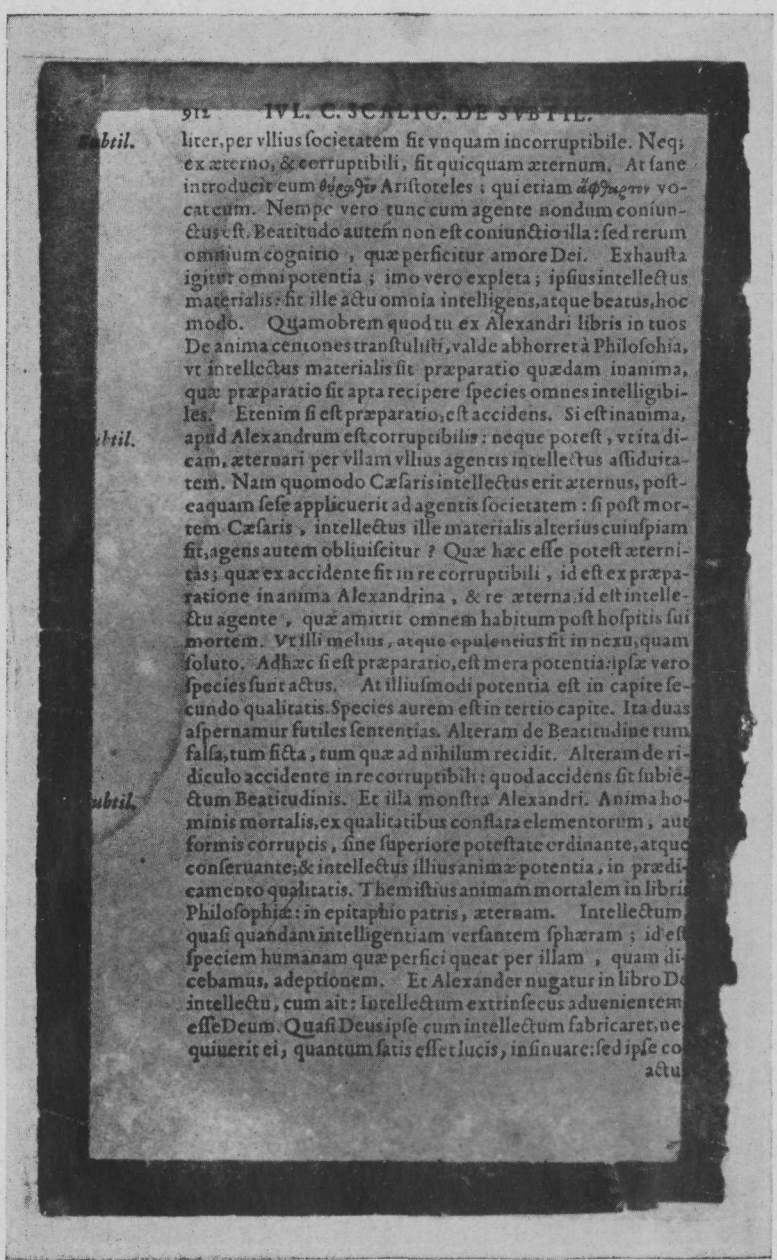
QVÆRIS præterea, quomodo Cœli iuncti sunt, atque id his quidem verbis. Si vna est superficies, caua superioris, & conuexa inferioris, quomodo in diuersas partes superius, & inferius Cœlum moueri poterit? Si duæ sunt: indiuisibile ab indiuisibili tangitur. Hanc nos supra discussimus difficultatem. Quare hic non est repetenda. Neq; vero in solis corporibus cœlestibus versatur dubitatio, sed in omnibus corporibus. Nam quomodo tangit aer aquam? Solutio est: Quia superficies est diuisibilis in potentia. Naturalis quidem superficies pari potest diuisionem: mathematica non. Est enim imaginaria: ex qua corpus nullum constituitur. Qui locus pertinet ad eam Philosophiæ partem, quæ tractat minimorum naturalium vel quantitatem, vel vnionem. Et ad illam, quæ perscrutatur, quomodo fiat initium motus, si corpori mobili pertranseundum spatium est, quod diuidi aptum est in infinitum. Quemadmodum in superioribus disputatum est. Ait Philosophus: in potentia corpus illud esse, non actu diuisibile. Ergo actu designat quantitatem, quæ totius sit initium spatii, & in ipso moto, & in ipso motu. Superficies vero non solum diuisibilis, sed etiam terminans, & qua terminat, est indiuisibilis: Sic indiuisibile tangitur ab indiuisibili. Quod satis est, modo ne dicatur: indiuisibilium coitione constitui corpus. Ex non quanto enim fieri quantum, Platonicorum somnia sunt. Non enim quicquam confieri potest ex priuatione aut ex negatione, tanquam ex materia. Sophismata vero satis pro re, soluit Aristoteles. Quare suo ibi loco perpendenda sunt.

2. Que-

Figure 4

Class D sheet

Calcium Carbonate — 0.86%



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ubtil. liter, per vllius ſocietatem ſit vnquam incorruptibile. Neq; ex æterno, & corruptibili, ſit quicquam æternum. At ſane introducit eum θεοφόρητον Ariſtoteles; qui etiam ἄφθαρτον vocat eum. Nempe vero tunc cum agente nondum coniunctus eſt. Beatitudo autem non eſt coniunctio illa: ſed rerum omnium cognitio, quæ perficitur amore Dei. Exhauſta igitur omni potentia; imo vero expleta; ipſius intellectus materialis: ſit ille actu omnia intelligens, atque beatus, hoc modo. Quamobrem quod tu ex Alexandri libris in tuos De anima centones tranſtuliſti, valde abhorret à Philoſophia, vt intellectus materialis ſit præparatio quædam inanima, quæ præparatio ſit apta recipere ſpecies omnes intelligibiles. Etenim ſi eſt præparatio, eſt accidens. Si eſt inanima, ubtil. apud Alexandrum eſt corruptibilis: neque poteſt, vt ita dicam, æternari per vllam vllius agentis intellectus aſſiduitatem. Nam quomodo Cæſaris intellectus erit æternus, poſteaquam ſeſe applicuerit ad agentis ſocietatem: ſi poſt mortem Cæſaris, intellectus ille materialis alterius cuiuſpiam fit, agens autem obliuiſcitur? Quæ hæc eſſe poteſt æternitas; quæ ex accidente fit in re corruptibili, id eſt ex præparatione in anima Alexandrina, & re æterna, id eſt intellectu agente, quæ amittit omnem habitum poſt hoſpitis ſui mortem. Vt illi melius, atque opulentius ſit in nexu, quam ſoluto. Adhæc ſi eſt præparatio, eſt mera potentia: ipſæ vero ſpecies ſunt actus. At illiuſmodi potentia eſt in capite ſecundo qualitatis. Species autem eſt in tertio capite. Ita duas aſpernamur futiles ſententias. Alteram de Beatitudine tum falſa, tum ficta, tum quæ ad nihilum recidit. Alteram de ridiculo accidente in re corruptibili: quod accidens ſit ſubiectum Beatitudinis. Et illa monſtra Alexandri. Anima hominis mortalis, ex qualitatibus conflata elementorum, aut formis corruptis, ſine ſuperiore poteſtate ordinante, atque conſeruante; & intellectus illius animæ potentia, in prædicamento qualitatis. Themiſtius animam mortalem in libris Philoſophiæ: in epitaphio patris, æternam. Intellectum, quaſi quandam intelligentiam verſantem ſphæram; id eſt ſpeciem humanam quæ perfici queat per illam, quam dicebamus, adeptionem. Et Alexander nugatur in libro De intellectu, cum ait: Intellectum extrinſecus aduenientem eſſe Deum. Quaſi Deus ipſe cum intellectum fabricaret, nequiuerit ei, quantum ſatis eſſet lucis, inſinuare: ſed ipſe co actu

Figure 6

Class F sheet

Calcium Carbonate — 0.44%

paper" is largely cellulose. As manufactured, it is comparatively free of the presence of the deteriorating agents mentioned earlier, and its storage requires only that external agents of degradation be kept from coming in close and continuous contact with the paper; among these are air-borne acid fumes (sulfur dioxide from the burning of coal, sulfur dioxide and the oxides of nitrogen in industrial stack gases, etc.), ultraviolet light (from the sun), excess heat, dryness, or humidity (the combination of heat and humidity promotes the growth of microbiological forms which attack cellulose).

The results of a recent investigation of the condition of paper in an old book will serve as an illustration of the factors favoring the slow deterioration of even high-grade papers. The subject of the book is unimportant. It happened to be a text in Latin on the natural sciences; its publication date is 1576. The work was done at The Institute of Paper Chemistry by a student [Hanson, Fred S. Resistance of Paper to Natural Aging. *Paper Ind. & Paper World* 20, No. 11:1157-63 (February, 1939)]. In this book some of the signatures were brown in color and weak in strength; in others, the paper was white and quite strong. Why the difference? The fiber furnishes of the two contrasting materials were the same — namely, a mixture of linen and cotton with about 3% of raw linen fibers in each. The chief chemical constituent of the fibers making up the paper consequently was cellulose. The mechanical preparation seemed to be about the same, for the fibers were long and considerably broomed. One significant difference was found to be the ash content; the weak brown sheet contained not more than 0.75%, whereas the ash in the white sheet tested better than 2.5%. The amount of iron was the same. Paralleling the difference in ash was the difference in lime, the main constituent of the ash. Somewhat related to the difference in ash was the difference in acidity of a water extract of the papers. The extract from the white paper was slightly on the alkaline side, whereas that of the brown paper was acid. The slight alkalinity of the extract of the white paper is due to the lime content of the ash which served to buffer any acids formed during aging and, thus, prevented abnormal deterioration of the paper. The samples of paper, when arranged in order of increasing brownness, appeared exactly in inverse order of calcium carbonate content.

Other interesting points were noted. One had to do with the aging by the ink and its component oils and pigments. The linseed oil in the brown sheet was shown to have been converted to organic

acids in a highly oxidized condition. This was not the case in the white sheet. The acids also had diffused throughout the entire sheet in the completely brown sheets; with the partially brown sheets, the acids had diffused through the brown areas.

This report shows the effect of at least one of the deteriorating agents — sheet acidity. Oxalic acid was found useful as a means of brightening the various samples; the white samples were raised in brightness as much as 20 points, the brown samples about 5 points through removal of iron and, probably, a conversion of calcium carbonate to calcium oxalate.

The effect of atmospheric acids has been brought out by the work done at the National Bureau of Standards and described in an article by A. E. Kimberly and B. W. Scribner [Bur. of Standards, *Miscellaneous Publication No. 144* (1934). 27 pages]. These men, in a series of systematic studies of the problem of preserving records extending over four years, have described the effect of exposing papers to atmospheric sulfur dioxide gas with the measurement of the degrading effects of the gas. Experimental tests showed that this gas could be completely removed from the atmosphere by washing the air with an alkaline wash. The destructive effect of light, adverse temperature, and humidity are also indicated. Many other papers on the preservation of records and the whole problem of permanence and durability of old papers will be found in the reports from the National Bureau of Standards.

A variety of projects in this general field have been carried out in the laboratories of The Institute of Paper Chemistry.

Reference was made on an earlier page to the new and highly purified wood pulps such as those which have been sold in the past under the name of alpha pulps. One of the first studies made by The Institute of Paper Chemistry dealt with the relative stability of high-grade rag stock and purified wood pulp in order to determine whether the purified wood pulp could be substituted for the high-grade rag stock. In this project, the various pulps were degraded by heat, light, alkaline solutions, acid solutions, and bleach. The rate of degradation was followed by estimating the changes in the chemical composition of the products. The data show that high-grade rag stocks with their higher purities resist degradation, as measured in this way, for a longer period than do the purified wood pulps and low-grade rag stocks. The suggestion from this is that, all things being equal in connection with the paper manufacturing process — such as content of alum and size and the like — the paper from the high-grade stock would probably last longer under

equivalent storage than would paper from either the purified wood pulps or the lower grade rag stocks. In connection with this program, paper was made in February, 1933 using high-grade rag stock on the one hand and purified wood pulp on the other under similar and optimum conditions, and this paper is now on test. After fifteen years of aging there is very little relative loss in strength in either type of paper. The rate of loss in folding endurance — the only strength property to change in the fifteen years — is approximately the same for each of the papers but, since the purified wood pulp paper had a considerably lower original folding strength, we might expect it to lose its fold sometime sooner than would the paper from the high-grade rag stock. Specifications for permanent records are directed toward insuring a sheet of high alpha-cellulose content (resistant cellulose) and low acidity and low rosin content.

The preceding discussion relates specifically to papers intended for permanent records. The archivist, however, may be just as much concerned with papers of cheaper furnish — such as groundwood-chemical pulp mixtures. The conditions which shorten the life of a "permanent" sheet have an even greater over-all effect on the life-expectancy of the poorer quality papers. Free acid and rosin in the sheet contribute to its deterioration. This is not noticeable where the sheet is used conventionally, for the greater percentage of such paper today needs only a relatively short use life.

In spite of the fact that papers in general meet their principal use requirement in terms of sheet life, appearance, and strength, the paper manufacturer is constantly striving to improve his product. For example, the development of a process for making a groundwood sheet which is stable as to color and strength would be of very real interest provided the new process would not add too greatly to the cost of production.

Unfortunately, not too much is known about the factors affecting the color and strength of groundwood, particularly on exposure to light. In order to remedy this, the Groundwood Association initiated a project dealing with the nature of fading in groundwood papers at The Institute of Paper Chemistry. "Fading" is the term used to describe the color changes taking place in a groundwood sheet on exposure to sunlight. Newsprint, poster paper, and the like, after exposure, first become somewhat lighter in color; then, as exposure is continued, they darken very noticeably. With this change in color, there is a corresponding loss in strength. Although the project was ended before all the answers to the question could be obtained, some very definite steps forward were made in under-

standing the change in composition which accompanies the change in color.

The reaction is an extremely complex one in which both light and atmospheric oxygen play a role. Elevated temperatures and increased humidities accelerate the rate of fading. The main component of the groundwood sheet which appears to be changed by oxygen in the presence of ultraviolet light, with subsequent production of color, is lignin. These studies indicated a number of ways that might possibly be used by the papermaker to improve the qualities of his groundwood sheets. Some of these were tried. One was to use a material which we call an "antioxidant" to prevent oxidation. This was not successful. A second was to put in a material which would absorb the ultraviolet light which changes the lignin; a number of compounds were found that would do this (in part at least), but their cost was prohibitive. This directed us toward a third method for controlling the influence of light on the groundwood sheets — stabilizing the unstable color-producing components of groundwood by modifying them. Something like this happens when groundwood pulp is bleached with sodium peroxide. A very much better color results, and sheets made of bleached sulfite pulp and bleached groundwood might prove to be of interest where records occasionally have value as archivists' items.

No attempt will be made to review in detail all the other investigations made at The Institute of Paper Chemistry relating to an understanding or control of natural aging of paper. Reference will be made rather briefly to two.

The first deals with the effect of ultraviolet light on cellulose, the main constituent of high-grade rag paper. From the research, we understand better how cellulose is broken down by ultraviolet light in the presence of oxygen. The reaction products all exhibit the properties expected of cellulose degradation products. The further discovery that cellulose, after irradiation in oxygen, continues to break down, even when stored in the dark, has a practical bearing on the display of documents in museums where ultraviolet light and air can get to them. Permanent exhibition under these conditions may be bad, but even temporary and occasional exhibition of such documents may be attended by a continuing breakdown after they are removed from the display case. This effect is referred to as a "post-irradiation effect." [Stillings, R. A., and Van Nostrand, R. J. The Action of Ultraviolet Light upon Cellulose. *J. Am. Chem. Soc.*, 66, no. 5:753-60 (May, 1944); Heuser, E., and Chamberlin, G. N. The Action of Ultraviolet Light upon

Cellulose and Cellulose Triacetate. *J. Am. Chem. Soc.*, 68, no. 1:79-83 (January, 1946)]. The post-irradiation effect can be stopped by storage in the dark in nitrogen or in helium.

Still another series of investigations has been carried out in our lignin laboratory. "Native" lignin, one form of the color-producing lignin in paper made by the groundwood process, has been shown to possess one reactive component which is extremely susceptible to the action of light. When this component is protected, changes in the color of lignin on exposure to light take place only slowly. This is true whether the lignin is isolated or is in wood. Unfortunately, we have not yet been able to achieve this result on a technical scale with the lignin in paper without, at the same time, affecting certain of the other properties of the paper.

The above discussion has related largely to studies of the mechanism of deterioration of paper. The archivist is also interested in determining the age of a document and whether it is the actual document it is represented to be. One way of checking the age is to determine the type of pulp used in making the paper. One of the members of the staff of the Institute has devoted the greater share of his technical life to developing and improving the methods which serve to identify and estimate the different pulps in the furnish. Since the groundwood process was not introduced in Europe until 1840 and in this country just after the Civil War, the presence of groundwood establishes the earliest possible date of manufacture. Similarly the soda process was first used in 1863 and the sulfite process in 1874. These three pulps are found in ordinary printing paper. Bleached sulfate and purified chemical pulps were not used until about 25 years ago. These can also be identified in a sheet.

This brief report should not be closed without an explanation being given to the function of The Institute of Paper Chemistry. The Institute was organized in 1929 shortly after the stock market crash by nineteen pulp and paper mills of the State of Wisconsin. This was to be a graduate school devoted to the training of technical men for the pulp and paper industry, but it was also to provide both research facilities for studying problems dealing with the manufacture and use of pulp and paper, and library facilities. These three functions have been carried out on an expanding scale ever since 1930 when the first class of three students entered in February. The Institute has grown and today receives its support from all over the United States. The Institute of Paper Chemistry currently is the co-operative educational expression of 107 corporations. Its physical equipment is housed in its own buildings on a

campus of approximately 30 acres. The staff includes about 200 men and women. Its activities embrace both teaching and research in the field not only of cellulose and lignin chemistry but also of the other sciences on which the industry is based, such as physics and biology which, together with chemistry, provide fundamental support for the various technologies of the industry. Its library and editorial facilities have expanded so that today there is an Editor, C. J. West, and members of the editorial staff, together with Miss Edith Stroschneider, Librarian, and her library staff. The Institute publishes a monthly technical abstract bulletin called the *Library Notes* of The Institute of Paper Chemistry, a quarterly research bulletin sent to its membership, numerous annotated bibliographies, and a variety of technical publications in the different scientific journals.

Its research program embraces fundamental studies of the type described above in connection with permanence and durability of various types of paper, fundamental and applied problems in the field of pulping, stock preparation, papermaking, conversion, and the like. It has special research laboratories adapted for work in studying the effect of paper mill effluents on fish life, other laboratories for determining the relative resistance of paper containers to penetration by insects, laboratories for research in wood technology and bacteriology, for studies of wood waste utilization, as well as the more conventional laboratories in chemistry and physics.

As in the beginning, its student body is limited to fifteen in a class. The course, purely postgraduate, takes approximately four years and leads to the degrees of Master of Science and Doctor of Philosophy. These degrees are conferred by Lawrence College with which the Institute is affiliated. Since the Institute opened its doors, approximately 250 students have matriculated. Including the graduates of June, 1948 it will have conferred 92 Doctor of Philosophy degrees and 148 Master of Science degrees. One hundred and fifty of its alumni and former students have entered, and are actively engaged in, the paper industry. Buildings and equipment could not be duplicated today for $2,000,000.

The students of the Institute are selected following the visitation of university and college campuses by representatives of the Institute. They must have demonstrated in their undergraduate work the ability to handle difficult technical assignments. Their preparation must have included such basic courses in chemistry, physics, and mathematics as are ordinarily recommended by the American Chemical Society and the American Institute of Chemical Engineers for

professional training in those fields. Here an ideal combination of academic atmosphere and tradition is blended with the atmosphere of the industrial research laboratory. The thirty-eight men and women who make up its teaching staff have had some contact with the paper industry or other industries of the same general type. From programs such as this will come the men and the ideas on which better publication media will be built.

SUMMARY

The above paper has presented a review of those researches which have increased our knowledge of the causes and mechanisms of paper aging. No attempt has been made to describe the methods which have been developed for the preservation of documents.

A considerable gap exists between our knowledge as to the causes for accelerated aging and the application of this knowledge in paper manufacture and paper conversion. This is due to a number of factors, but the main one is the fact that most paper as made meets its normal use requirements, and longevity is not a normal requirement. Only a small percentage of the paper manufactured and printed becomes of interest to the archivist, and the problem is to manufacture and print all papers so as to achieve the maximum life without affecting adversely the normal papermaking and printing operations. This is a real undertaking.