A RECORD BREAKING PROBLEM

RICHARD E. HILL
4632 E. 14th Street
Tucson, AZ 85711

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Abstract

Tests were made to examine the fading of a number of inks with exposure to sunlight. Tests were also made to examine the stability of electro-static copies (xeroxes). The results have important implications for amateur astronomers and all others who maintain written records.

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In amateur astronomy, proper and complete record keeping is essential. I realized this some 20 years ago, after I had been observing for about six years. Some of those logs from 1965 have survived, though about half were destroyed during my term of enlistment in the Navy when they were in the care of a younger sibling. While going through the old logs and others from only 10 years ago, I noticed that in some cases the ink was light and in others there was a grease stain in the paper around the writing. This piqued my interest in the permanence of the astronomical records we keep. With the proliferation of writing implements, inks, papers, and copying media today a study in the longevity of these seemed to be worthwhile. I have always had an interest in the archival storage of written records and now this interest could be applied to this investigation.

Experiments were devised similar to those used by pigment manufacturers. It was decided to use about 20 different inks, one erasable ink, and one pencil (to act as a check on the permanence of drawings). A line was written with each pen on the same sheet of paper and the date noted. The sheet was then encased in plastic and left in the sun at 2500 feet altitude in low humidity (for the most part). The plastic prevented any possible precipitation from soaking the paper and thus affecting the results. Four tests were conducted in 1986 and two more in 1987. The first two tests lasted 2 weeks each, the third 3 weeks, the fourth 2 weeks, and the last again 3 weeks. The number of hours of sunlight exposure was not constant due to the vagaries of weather, and no attempt was made to correct for this. The papers used in the tests were of different types. Writing implements used in the tests are listed in Table I.

Analysis of the results revealed some surprises. The most obvious change was that ALL fine point fiber tip pens had faded significantly, some to near invisibility, in ALL tests. Nylon point pens fared a bit better. All PaperMate ballpoint pens showed no appreciable fading. The EraserMate ballpoint showed little fading and even became relatively permanent. The liquid ink ballpoints also showed minor fading, some more than others. Ordinary pencil lead demonstrated no change even after 3 weeks.

After discussing the matter with a number of those familiar with inks, a hypothesis was arrived at to explain the observed phenomena. Those pens that fared best had a common parameter. They contained pigment ink rather than dye ink. A dye ink simply stains while the pigment ink actually puts dark matter on the paper and the medium the pigment is mixed in ideally carries it into the paper fiber. This explains the stability of the pencil lead and why old logs of the last

century and before, written in with India inks, have lasted for so long. They both apply a dark matter to the paper and imbed it into the fiber. In the case of pencil it is graphite, and for India ink it is lamp black made into paste and suspended in gum arabic.

If a long-lasting record is desired, consideration should also be given to papers used. According to some recent studies (Raloff 1983) many cheaper grades of paper go through a process called "acidification" where the alum sizing on the paper (aluminum sulfate) that keeps ink from spreading gradually turns to sulfuric acid, thus making the paper turn yellow or brown and brittle. It is a slow chemical burning. Paperback books are an excellent and extreme example of this type of paper and exhibit this phenomenon, becoming so brittle after a couple of decades that they often can be crushed in one hand! Newspaper is even worse, showing these effects in a matter of weeks. There is a chemical process very similar to evacuation hypersensitizing of astronomical emulsions that can reverse or slow this degradation but it is costly and experimental, on the order of $30 per average sized book (in 1982). For archival records it is recommended that rag or alkaline papers (called "acid free" papers) be used.

For old logs already in existence there are a few methods by which such degradation can be slowed. Without any precautions the average book or notebook will last only 25 to 100 years. This can be greatly increased by keeping all such archival materials in a dry, cool environment. At 50°F with a relative humidity of 10% (which can be achieved for a small area with little effort) such materials could last up to 1000 years! This would be more than enough to annoy most of our descendants. By thoroughly dessiccating a book and then wrapping it in airtight plastic such as SaranWrap, and then freezing it at around -25°F, that book could last for thousands of years!

Other tests have been conducted recently as well. For years we have heard warnings about the longevity of electro-static copies (ESC's) or as many simply refer to them, xeroxes. At first, during the early years of ESC's, it was generally agreed that they were of limited longevity. This led to the request from many organizations that only original copies of data, and not ESC's be submitted for archival storage. It was wondered whether the intervening years had led to advances in the lifetime of ESC's. Two randomly chosen copiers were originally tested, one a SAVIN and the other a KODAK. A second test was conducted using a XEROX copy as well. Copies were exposed to no less than 3 weeks of direct sunlight at 2500 feet altitude with low humidity as in the ink tests. The results were totally unexpected and startling. They were more stable by far than similar copies of a decade ago and in many cases they were more stable than the originals! This was particularly true if the originals were made with the new, fine fiber point, dye ink pens.

In summary, two types of pens seem to be the best overall. These are the ordinary ballpoint pens (especially PaperMate), with the liquid ink roller ball (pigment ink) pens playing close seconds. But the use of ordinary ballpoint pens with the pasty, grease-based inks may lead to a diffusion of the grease base into the surrounding paper. This was probably the source of the stains evident in my old logs. This hypothesis has yet to be tested. Such diffusion takes years to occur. It is recommended, in lieu of further tests, that only good quality pens be used.

Any paper should be an alkaline, acid-free or rag paper and not the cheaper, recycled papers and definitely not the soft newsprint papers. Price and rag content are often coincident and are pretty good indicators of paper quality, with the better papers of higher rag content costing more and lasting longer.

For those who have old logs, no matter how old, that use other materials, consideration should be given to making electro-static copies of them. This is especially true if there is some degradation already occurring either in the paper or recording medium.

While it is always desirable to have properly recorded original copies of data on file it would seem from these tests that strict adherance to such a policy may not be wise. As has been shown, in some cases the copies are more stable over long time periods than originals made with inferior writing implements. Those with original-only policies may want to reconsider this policy.

These tests have been very informative. They are not definitive of course, but do act as a good guide for further investigations which are being conducted. Amateur astronomers should not take this matter or the recommendations herein too lightly. It can be heartbreaking to open an old journal or log only to see the years of careful, painstaking observations crumble before your eyes.

REFERENCE

Raloff, J. 1983, **Science News 123**, 154.

TABLE I

Writing Implements Used in Ink Tests

EraserMate erasable ink
PaperMate Medium Point ballpoint pens
in red, blue, and black inks
Berol Fine Point (0.5mm point)
Berol Thinliner nylon point
Pentel Rolling Writer
Pentel Fine Superball
PaperMate Accu-point
Ultra Fine Flair (0.5mm point)
BIC Roller (Liquid ballpoint)
BIC Felt Point Medium
BIC Ballpoint (fine)
PILOT Precision Rolling ballpoint
PILOT Razorpoint
PILOT Precise Rolling Ball
Stylist (NIJI) Fine Point
Pigma 0.3mm liquid ink ballpoint
Sharpie Permanent Marker
Uniball Micro, Faber-Castell
HB Pencil

Note: Not all of these inks were used in all tests.