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Another update on computer printer inks and papers for internal labelling of fluid-preserved specimens

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Abstract
Since the advent of the PC there has always been a debate to improve the appearance of labels in jars of biological specimens preserved in fluids ('wet collections'). The debate centres around which ink and which paper is going to look the best and last indefinitely? The problem is long-term testing.

Introduction
Ever since my first label was written in the Natural History Museum's arachnid section back in 1968 I have always maintained that the best way of retaining vital data on a label immersed in preserving fluids, of which many are also solvents, is using handwritten Indian ink on 'Goatskin Parchment' paper. Bear in mind that these fluids are continuously being contaminated with dissolved organic compounds from the preserved specimens.
Since personal computers appeared there has been an ever-increasing number of inks that purportedly 'last for ever' in preserving fluids of all kinds. In reality these may be stable during our working lives but may not last beyond another 30 years.
I have always maintained that a back-up label in the fluid is essential, comprising goat skin parchment with required data written in Indian ink (see also inks).

Papers
There are various papers which have been found to be suitable for this purpose:
Goatskin Parchment (Arjo Wiggins and Wiggins Teape –see suppliers), Tyvek and Resistall. None of these was apparently perfect since Goatskin Parchment used not to be not white enough for some, although there has been a white version available for some time.
Tyvek is also white but tends to be fibrous and ink can bleed into it giving a slightly smudgy and unsatisfactory data set (Fig. 4). However it has been found to be good for printing (see further down).
Resistall also is good but recent research shows that it is acidic due to its manufacturing process and can lower pH levels in smaller containers (up to c. 400ml).

Inks & pens
Computer inks will produce a perfect-looking and professionally-styled label but the problem is of longevity.
Studies were carried out back in the 1990s to find which was most suitable.
Some faded or gradually dissolved away in the fluid and turning it blue, other inked letterings lost their adhesion to the paper and detached to the bottom of the jar as 'alphabet soup' (Wheeler *et al.*, 2001)
The debate is still continuing today although many notable improvements have since been made.

Pigment ink pens are good and those supplied by Edding (1800 or 1880 series) have lasted well since 1991 and show little or no sign of fading in an assortment of preserving fluids, including (alkaline) potassium acetate and glycerol mix (Kaiserling 3).
Pigma pens have shown a slight instability in alcohol (IMS or Industrial Methylated Spirit) and have noticeably faded (Bristol University Pers. Comm.).
In each case the ink should be left to dry for at least 5 minutes prior to immersion.

Test against fading and solution over 7 years
Samples of Old (cream coloured) and New (white) Goatskin Parchments and Resistall were labelled using an old Amstrad PCW dot matrix printer (normal print an bold, and no longer available!), Indian ink, and Edding profipen pigment ink. These labels were immersed into 80% IMS, 10% formalin (4% formaldehyde, aqueous solution), Formol-Saline (as before but with additional 1% sodium chloride), Kaiserling 3 Preservative, Steedman's fixative (10% formalin, propylene glycol and propylene phenoxetol) and Steedman's PFP (post-fixation preservative: same formulation minus the formalin). There were no specimens or additives put into the jars – the testing was purely for fading and any ageing effect of solution on the inks and papers.

The 'Goatskin' labels were immersed in the fluids on 6.12.1999 and the Resistall (after a delay in delivery) on 10.2.2000.
pH reading of the fluids were taken and the jars were stored at the back of the laboratory, subject to day-to-day UV dosage, fluctuations in humidity and temperature. To ensure evenness, the printer ribbon was renewed for the two dates.
On 11.5.2007, the labels were removed, rinsed in deionised water, blotted and air-dried and then photographed without flash and using the same light source for each. pH readings of the fluids were also taken to check for any difference but bear in mind that all of the papers were in the same jar of each fluid for the duration of the test.

Results

(GP = Goatskin Parchment paper)

Table 1
Dot Matrix with lower line of print emboldened
(Fade number: 0 = no fading ---- 7 = ink barely visible

Fluid	GP old	GP new	Resistall	pH start	pH finish	
80% IMS	2	0	3	8.0	5.5	
Steedman fix	2	0	3	7.5	5.5	
Steedman PFP	2	0	3	8.2	7.5	
Kaiserling 3	1	1	1	7.4	8.0	
Formalin 10%	0	0	0	7.9	5.0	
Formol-Saline	1	0	2	7.9	6.0	

Table 2
Indian Ink (fade number: 0 = no fading ---- 7 = barely visible)

Fluid	GP old	GP new	Resistall	pH start	pH finish	
80% IMS	0	0	0	8.0	5.5	
Steedman fix	0	0	0	7.5	5.5	
Steedman PFP	0	0	0	8.2	7.5	
Kaiserling 3	0	0	0	7.4	8.0	
Formalin 10%	0	0	0	7.9	5.0	
Formol-Saline	0	0	0	7.9	6.0	

Table 3
Edding pen (fade number: 0 = no fading ---- 7 = barely visible)

Fluid	GP old	GP new	Resistall	pH start	pH finish	
80% IMS	0	0	1	8.0	5.5	
Steedman fix	1	1	1	7.5	5.5	
Steedman PFP	0	0	0	8.2	7.5	
Kaiserling 3	1	1	1	7.4	8.0	
Formalin 10%	1	1	1	7.9	5.0	
Formol-Saline	0	1	0	7.9	8.0	

Conclusions from tests
More recent computer printer inks were unavailable to be tested with this batch of labels.
The reduction in pH of all of the fluids is significant.
Because the labels were together in each jar of fluid, it was not possible to tell which one might have lowered the pH although the presumed acidity of the Resistall may have been responsible. The dot matrix double line survived well throughout the test and should be still visible after 10 years in these fluids. The white Goatskin Parchment came out best of this test. Others (including A.Bentley) have found dot matrix printing to survive well but due to the paucity of such printers this result is unfortunately obsolete!
The Indian ink showed no fading at all throughout for each paper in any of the fluids.

The Edding pen showed the slightest fall-off in the same conditions, which was not due to its being less intense than Indian ink.
The results show that for the three papers tested, the fall-off in visibility was slight; new Goatskin Parchment came out the best overall and the Resistall only came off slightly worse with the dot matrix printer.
The above tests were carried out without specimens purely to test the ageing effect of the fluids and any allied effect on the papers and printings.

Other problems
There are several problems to take into account when testing inks and papers in jars of natural science specimens.
Contamination of the preserving fluid by the specimen: lipids that oxidise, natural pigments and many other organic compounds can leach into the preservative over years and can contribute to (non Indian-) ink and paper degradation especially if the contamination is due to lipid or fluid dilution through evaporation.
Lipids that leach out into preservatives will eventually oxidize into fatty acids and lower the pH of the fluid, endangering both the specimen and its label.
Contamination though decaying agents such as fungi are well-known, occurring in jars of fluids whose levels are low and where IMS or formaldehyde concentration levels have also fallen. Fungal hyphae have been noted in IMS at 30% strength and in 1% formaldehyde (2.5% formalin) and will start to produce a mixture of digestive enzymes as concentrations fall further.

Abrasion can occur through the movement of hard-bodies in jars: arthropod exoskeletons, claws, beaks, horns &c., rubbing against the label surface each time the jar is moved. For geological specimens the same applies to almost any type of specimen, especially grits, that can rub against the label.

Dense fluids such as oils, glycols including glycerol can soften some papers particularly if the fluid's pH level is below 4.5. Solvent clearing agents such as turpentine and methyl benzoate will cause a label to become semi-transparent and may cause it to embrittle over time.

Updates on printers and inks - the debate continues…
This information has been taken from Yale University's NH- COLL forum.
A M Snyder says that the Epson LQ870 (ESC P2) works well with Resistall and Tyvek labels and still holds up after 20 years, but also recommends a back-up label using 'Eternal' ink.
Zala *et al.* tested laser inks and labels, incoporating artificial ageing using microwaves. Some labels were sprayed with acrylic resin. This exercise was carried out over a 14 year period but with no specimens in the jars. Also, since the containers were small, the labels were in tight contact with the glass of the jar so that letter damage through abrasion in the jar, was inadvertently kept to a minimum.
Erik Ahlander, Sweden (pers. comm.) has used laser-printed labels at NRM, Stockholm originally sprayed with Letraset spray (cf. Letracote) but due to unavailability of this product uses a hot iron with the labels face down on a sheet of clean paper, to ensure ink fastness by thermal welding. He also noted three drawbacks:
1 Lipid/oil-rich fish, including eels and salmon may destroy the labels.
2 When sending loans (in poly-bags) the text could bond with the plastic bag surface, requiring the label to be folded and pencil-marked with the accession number.
3 When the printer is low on toner, the text becomes *(sic)* sensible (=more sensitive).
Andy Bentley (2004) of Kansas University and who manages fish collections, states that the solution lies in thermal transfer printer technology and spun-bound polyester media with a wax/resin combination ribbon which is sold by Alpha Systems in Virginia: www.alphasystemsva.com

Conclusions
This paper has outlined many varied techniques and possible panaceas to the ongoing problems of producing museum-quality labels for wet collections.
With ever-shrinking budgets and staff levels, in-depth research time is becoming increasingly dificult.
The main factor is that artificially ageing or accelerating the experiments will produce false parameters.
To bear this out, Oliver Crimmen (pers. comm.) has found that after 20 years some hitherto finely-(computer)-inked labels started to delaminate.
This rather leads onto to the thinking that a back-up accession number written in Indian Ink is still advisable.
Genuine (long-term) ageing seems to be the only real test for these printer inks and papers. By the time

they have outlasted this generation of conservators and curators IT will have advanced so much that these results (like my dot matrix printing) will have been long obsolete!

Suppliers of papers
Goatskin Parchment/s: Arjo Wiggins www.arjowigginsfinepapers.co.uk
Minimum order of £250 via Antalis www.antalis.co.uk
Wiggins Teape Ltd., Gateway House, Wade Road, Basingstoke RG24 8QN.
Cream or blue-white 500 sheets minimum order. Telephone 01256 724724.
Resistall (made by Byron, Westall Paper Company) and Tyvek: Preservation Equipment Ltd, (PEL), Vinces Road, Diss, Norfolk IP22 4HQ. www.preservationequipment.com Telephone 01379 647400.
Spun-bound polyester media with a wax/resin combination ribbon:
Alpha Systems in Virginia: www.alphasystemsva.com

References

Bentley, A C: 2004. Thermal transfer printers – applications in wet collections. *SPNHC Newsletter* **18** (2): 1-2 & 17-18.
Wheeler T A, Huber J T & Currie D C: 2001. *Label data standards for terrestrial arthropods.* Biological Survey of Canada (Terrestrial Arthropods). Ottawa, Canada.
Zala K, Pentcheff N D & Wetzer, R: 2005. Laser-printed labels in wet collections: will they hold up? *Collection Forum* **19** (1-2): 49-56.

Samples of White (new) Goatskin parchment, Resistall and Cream (old) Goatskin parchment' printed with dot matrix (normal and bold) and Indian ink and Edding profipen (pigment ink). Samples result after with-drawing from preserving fluids on 11th of May 2007, started on 6th of December 1999 and (Resistall) on 10th of February 2000.

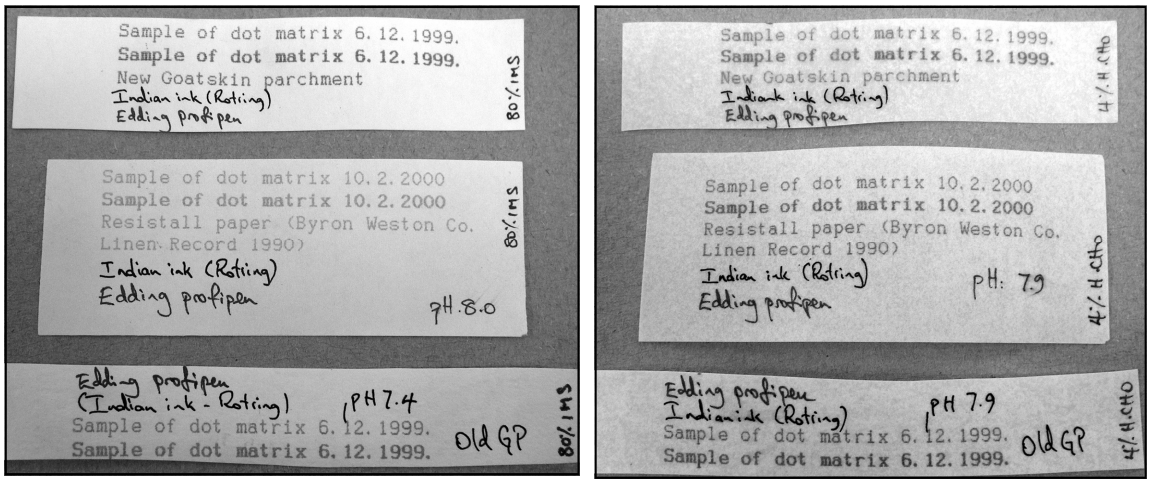

Fig 1. From preserving fluids 80% IMS (left) and 10% formalin (right)

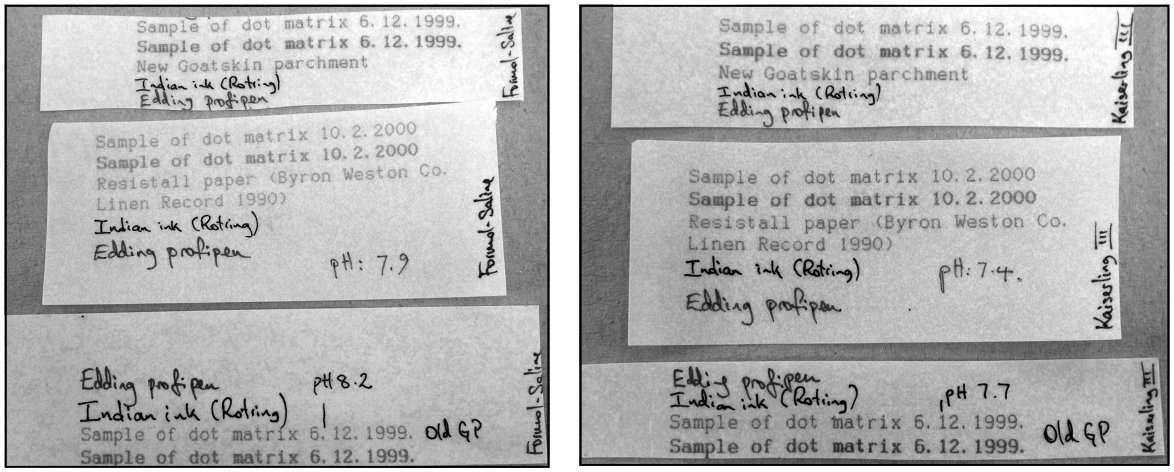

Fig 2. From preserving fluids 10% formol-saline (left) and Kaiserling III (right)

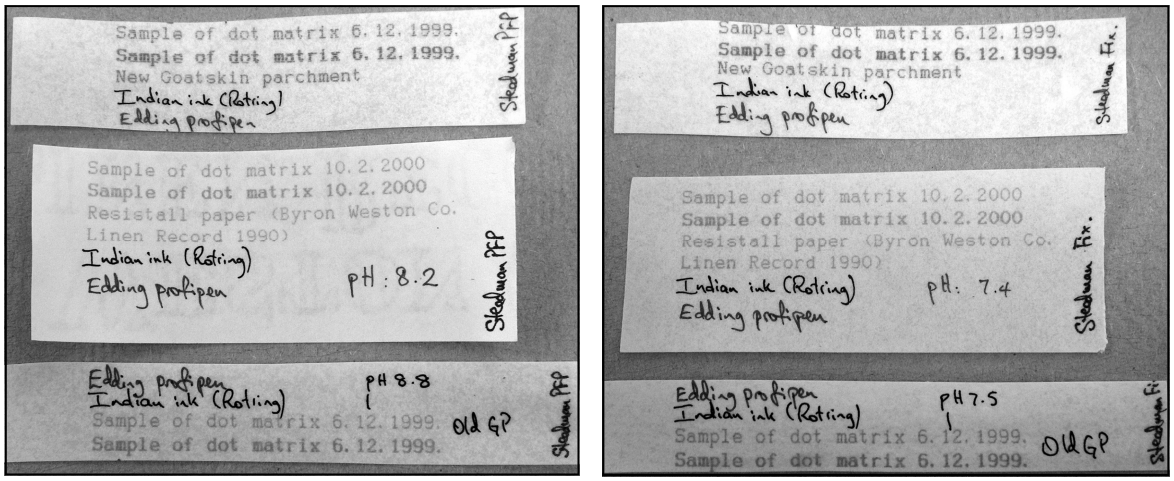

Fig 3. From preserving fluids Steedman's poft-fixation preservative and Steedmans's fixative.

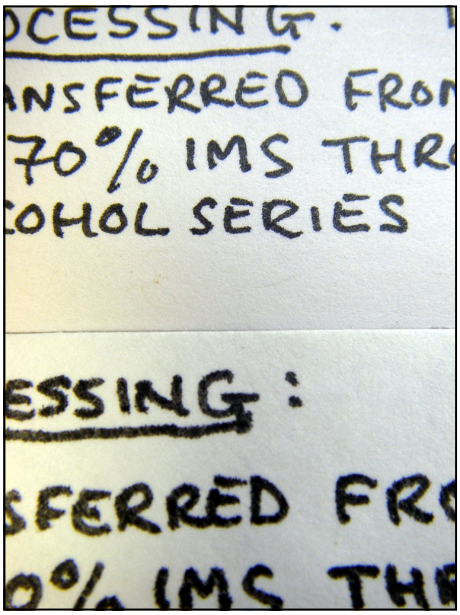

Fig 4. The fibrosity of Tyvek (lower) causes ink to leach out slightly into the paper giving a smudgy effect before immersion.