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The Manufacture and Use of Papyrus in Ancient Egypt

Much of what we know of ancient world we've learned from papyrus; however, we know almost nothing of papyrus in the ancient world. For more than one hundred years, scientists and historians calling themselves papyrologists have devoted themselves to the study of papyrus manuscripts. While papyrology has examined and expanded our understanding of ancient manuscripts, our knowledge of the physical documents, and the work that went into their construction, remains at almost nothing; the most renowned papyrologists know little about the history, the manufacture, and the use of the papyri that give their profession its name. In places where papyrologists' knowledge of the materiality of their trade is more than nothing, they have often replaced this with blind adherence to inaccurate or inaccurately interpreted descriptions of papyrus, its manufacture, and its use in antiquity. Actual attempts at the papyrus making process, rigorous historical examination and exploration, and attempts that incorporate and involve historic, scientific, and experimental aspects of the papyrus-making process will begin to paint a more accurate picture of the procedure and use of papyrus in antiquity. The importance of this approach is exemplified in the analyses of the preconceptions that papyrus' brittleness, weaker nature, and lower quality led to its replacement by parchment and later paper as the primary writing material in Europe, and that papyrus was created and held together with the addition of a paste or muddy water from the Nile during its manufacture.

Papyrus vs. Parchment: A Question of Quality?

To a contemporary reader, and even a contemporary papyrologist, the word papyrus

will often conjure two images: one of new papyrus and one of old papyrus. The popular image of new papyrus takes the form of speckled, yellow, stiff sheets, scrawled upon with Egyptian pictures and hieroglyphics painted in colorful inks. On the other hand, old papyrus is stereotypically dirty, crumpled, fragmented, and intensely delicate pieces remaining from a scroll that has otherwise completely disintegrated over time. To the contemporary reader holding these images, the replacement of papyrus with parchment seems obvious, inevitable and intelligent. In reality, the current popular conception of papyrus is in direct opposition to historic reality in almost every facet.

While the roots of these images and the popularly held conceptions of its quality are largely inaccurate, they are extremely complex and not entirely without justification. Modern papyrus[1], when made of from the papyrus plant[2], is intentionally modeled to resemble the familiar images we carry of old papyrus. To these ends, its contemporary manufacturers employ materials, procedures, and processes completely disparate from those practiced in papyrus production in antiquity.

Old papyrus's appearance and nature may be attributed to thousands of years of age and to serious abuse before it can be attributed to quality or status. The earliest and most famous archeological discovery of papyrus–and the discovery that defined our modern image of the material–was the unearthing of over eight-hundred papyrus scrolls in Herculaneum in

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[1]Papyrus products are widely produced as souvenirs in Egypt and for display as art and artifact worldwide (see the example of a the Canadian *Egyption Art Gallery* on the web at http://www.mbnet.mb.ca/eag/ for an example).

[2]Many contemporary "papyrus"-makers substitute strips of the papyrus plant with banana leaves which are cheaper and easier to manipulate into paper, but produce a vastly inferior product with that is much more yellow, brittle, speckled, and coarse than actual papyrus.

1752. The eruption of Mt. Vesuvius that buried Herculaneum acted to carbonize, harden, and eventually almost petrify most of the scrolls (Lewis, Papyrus and Ancient Writing 32). The brittle and yellowed scrolls from this excavation have become intimately connected with our conception of papyrus although their exceptional history makes them massively unrepresentative of papyrus more generally. A large group of other famous examples are from "rubbish mounds," in what is now desert, where the papyrus was abused and treated harshly before and after its disposal (Lewis, Papyrus and Ancient Writing 34). In lieu of these famous examples, and no widely known examples to the contrary, one hardly feels surprised at the popular image of papyrus as desiccated and browned paper fragments or newer papyri directly on an inevitable path to that status.

However, a more historic, scientific, and experimental exploration of the facts will provide an image of papyrus that is directly the opposite. Papyrus, as used in antiquity was white, durable, flexible, and long-lived. One of the foremost papyrologists, Naphtali Lewis, backs up his claim that well-made papyrus was extremely durable and "more flexible than linen" with an anecdote in Papyrus in Classical Antiquity (58). He tells that in the 1930's and 1940's, a curator at the Egyptian Museum in Berlin, Wilhelm Schubart, impressed patrons by cavalierly unrolling and rerolling a scroll of papyrus more than 3,000 years old (58). In another story, Lewis describes how a scroll first used in A.D. 144 for administrative records was used, sold as waste paper, repurchased, and whose *verso* (back) was then used to keep an estate manager's accounts 115 years later in A.D. 259 (Papyrus and Ancient Writing 32). These stories surprise readers as they paint a picture of papyrus that easily survive transport, use, storage, physical manipulation, and transfer over centuries and millennia without a serious degradation in quality. While modern images of papyrus are of a material that must be

treated delicately, even during its first use, papyrus in antiquity was very much the opposite. With decent care and sane treatment, it could keep this condition almost indefinitely.

As key in papyri's long term survival as their flexibility is their natural strength and durability. The overlooked and forgotten aspect of durability in papyrus can be effectively confronted with an examination of the alternative and secondary uses of papyrus as a plant as paper. Outside of paper, papyrus has enjoyed historical use as a material for boat construction[3], as a type of food or chewing gum, and as cordage in limestone quarries (Ryan 133-6). In these diverse uses, a material was needed with exceptional strength, durability, and resistance to stress and abuse; the ancients' choice of papyrus for all these roles effectively reveals the nature of papyrus. Perhaps the alternative and secondary uses of papyrus as paper in antiquity serve as even more relevant. After its use as a primary writing material, papyrus was routinely erased by washing with water, rubbing lightly, and resurfacing with a stone or shell without any deterioration to the papyrus' quality (Parkinson 47-48). The ability to recycle papyrus, especially due to expensive nature, was a key factor leading to its widespread use. Its ability to withstand a rough bout of washing would only be translated as disaster for any contemporary writing materials or type of paper. The commonality of washing and reusing papyrus is extremely important in generating an accurate conception of the material and a feel for its materiality.

Often however, papyrus even outlived its role as a writing material more generally and was recycled into other purposes where its strength could be utilized. Naphtali Lewis notes

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[3]The Norwegian anthropologist Thor Heyerdahl built two large sailing vessels out of papyrus and was eventually successful in navigating the Atlantic ocean to prove that the products of Egyptian boat construction would have been of a quality capable of making such voyages (Ryan 134).

that scrap papyrus was often used to form the stiff spine of bound codices (Papyrus in Classical Antiquity 95). In an unrelated discussion, he points out that even the famous Dead Sea scrolls were reinforced with a papyrus backing for strength when the leather they are written upon became friable (Papyrus in Classical Antiquity 58). When the vellum of the dead sea scrolls became weakened, the owners looked to extend the life of their scrolls with the use of papyrus. Their choice is exemplary of papyrus' superior durability and flexibility which serve as integral aspects of papyrus in antiquity; essential facets that been obscured and forgotten in contemporary conceptions of the writing material.

It was this durability and flexibility that Pliny the Elder discusses in the eighty-second section of his thirteenth book of Natural History when he attributes the fact that he had seen autograph texts of famous poets from hundreds of years before his own life (13.82) and it is due to the same durability and flexibility that we still have access to some of these texts. From Pliny's description, and from those of others in antiquity, we can begin to reconstruct a definition of papyrus that, while still woefully inadequate, now has a firm base in historic and scientific truth. Lewis concludes his exploration into papyrus in history by restating what he knows. Papryus is "white, flexible, durable, and its surface [is] shiny and smooth. It [is] not for lack of these qualities that papyrus gave way to parchment and paper" (Papyrus in Classical Antiquity 61). In reality, the end of the use of papyrus is much more complex than an simple debate over quality. An even-handed, extensive examination reveals that well-made papyrus has historically and scientifically been on an even or higher level of quality than that of parchment or paper. Papyrus is strong, durable, long-lasting and dependable. Its long-term use, reuse, and survival attest to this fact.

The Use of Paste or Glue in the Construction of Papyrus

Every sheet of papyrus is formed from two layers of parallel strips of the stalks of the papyrus plant running perpendicular to each other. How these two layers were joined together in antiquity has become a hotly contested concept in papyrology over the course of the last century. It has been the traditionally held belief that the two layers of papyrus are joined together using a glue or a paste that facilitates cohesion between the discrete layers. However, like the contemporary widely-held images and conceptions of quality that surround papyrus, an investigation of this procedure incorporating historic, scientific, and experimental perspectives will deduce that this conception is in fact, also completely inaccurate.

Like the misconceptions of the quality and nature of papyrus in antiquity, conceptions of the use of an additive bonding agent in papyrus are traceable and understandable, but in no way less inaccurate. Ignorance around the production of papyrus stems from the fact while that the craft of papyrus-making was actively practiced until the end of the eleventh century A.D., it stopped suddenly and completely when Egypt halted exportation of Papyrus to Europe and the Mediterranean at this time (Ryan 137). During the middle ages, the Renaissance, and the Enlightenment, explorations into the realm of papyrus-making were non-existent because Europeans believed the craft was a revealed and understood process.

This feeling, one whose effect is still strongly felt, stems from a canonical description of the manufacture of papyrus by Pliny the Elder in his long series of writings in Natural History. In his description, Pliny states that "paper of all kind is ’woven’ on a board moistened with water from the Nile, muddy liquid supplying the effect of glue" (13.77). Several passages later, Pliny again returns to the concept of a fixing agent as he describes a common paste "made of fine flour of the best quality mixed with boiling water, with a very

small sprinkle of vinegar" and describes how after "the paper is beaten thin with a mallet [it is] run over with a layer of paste" (13.82). Pliny's description sounds believable, reasonable, and even intuitive. To an audience of readers that were separated from the manufacture of papyrus by a thousand years and the geographic world, Pliny's description gives no reason for suspicion or doubt. It is this aspect of the nature of Pliny's description of processes, and papyrologists predictable reaction to it, that makes it dangerous. Because Pliny lived in antiquity, had seen papyrus, and had described the process in informed detail, it was easy for papyrologists to assume that Pliny was completely correct without a more thorough scientific, historic, or experimental investigation–this is exactly what happened. 'Knowlegde' of the system of papyrus manufacture became widespread and ingrained before it was tested or questioned.

When the process was first reattempted, it was during the eighteenth century, when James Bruce attempted to make papyrus in Abyssinia and Egypt on his Travels to Discover the Sources of the Nile. While Bruce admits that the products of his experiment were thick, heavy, never white, firm and rigid, he began to uncover the major problem with Pliny's description of the process–the fact that his project was completely successful independent of a paste or added adhesive. Bruce found that pressing the papyrus while moist was adequate to achieve sufficient results. Bruce conjectured that the parallel fibers were bonded by the "sugar or sweetness" of the juice inside the papyrus stalks[4] (Lucas 137-8). While Bruce's experiences kindled a flame of doubt in Pliny's description, Bruce could do little to overcome

[4]A great deal of field research has been done by the explosion this century of Egyptian papyrus manufacturers who have experimented, theorized, and researched aspects of papyrus-making. A leading expert and manufacturer Hasan Ragab has argued that the bonding of the fibers is due not to saccharide in the cell sap but to a physical bonding of the cell tissue of both layers (Parkinson 15).

the feelings of validity attached and entrenched around Pliny's version of the process.

However, it was with Bruce's example and experiment that placed the seed of doubt in Pliny's description and over the next few centuries, more educated Europeans began to follow in Bruce's footsteps. Professor Battiscombe Gunn began growing papyrus in his garden in Cairo and, by beating papyrus between two layers of linen, produced extremely successful examples of papyrus[5] (Cerny 6). Following and improving on Gunn's example were Dr. Ibscher, who cultivated and harvested papyrus in the Botanical Gardens in Berlin, Sicilian craftsmen anxious to revive the art (although their product was significantly more yellow and differing from papyrus in antiquity in this and other ways), and the famous Egypt scholar Alfred Lucas (Lucas 138). While these men's experiments differed drastically in many ways, and while each was geared toward proving a different hypothesis, they all abstained from the use of any adhesive additive and they all produced examples of papyrus that were of a quality that was either satisfactory or better. Through experimentation, papyrologists were able to call into questions that which had been inaccurately accepted as fact for millennia.

With papyrus being produced without the use of the Nile's muddy water, or any river water or any sort, the validity of Pliny's description faltered heavily. With high-quality papyrus being consistently manufactured in the absence of any paste or glue it began to buckle. Lucas, one of the early experimenters, stated that Pliny's account "is both obscure and wrong...although the Nile water during the flood is muddy, it does not contain anything that could possible act as an adhesive" (137). Later, Lucas' accusation was corroborated by an analysis of chemicals present in the Nile, in papyrus, and in any interactions between the two;

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[5]Gunn's papyrus was so successful it is now exhibited in the Cairo Museum. It is nearly white, although relatively speckled. Arguably, this speckling could be avoided using minimal extra precautions (Lucas 138).

all tests denied any properties or interactions that could lead to stickiness. These attacks, exemplified by Lucas' actions and experiments, questioned the previously immutable status of validity held in regard to Pliny's knowledge and, for the first time, began reevaluating his sources. Realistically, although Pliny obviously had more frequent and intimate dealings with papyrus in antiquity than contemporary scholars can hope for, his knowledge of the manufacture was second-hand at best, and the gaps in his knowledge may have been partially filled with misinformation or conjecture. Still, Lucas, Gunn, and Bruce's counterarguments continued to be weak without any historical support and validation.

Historical validation of the experimental investigations came through complementary scientific investigation. As Lewis states in Papyrus in Classical Antiquity, a chemical analysis of "thousands and thousands of extant ancient papyri show no evidence of any such [paste]" (67-8). Additionally, experimental investigation seems to imply that the use of any starch for adhesive purposes would have been extremely detrimental to the flexibility of the papyrus–one of the most important characteristics of the well-made finished product (Cerny 8). By incorporating another facet of papyrology–chemical exploration–papyrologists were able to uncover the practical inviability of Pliny's process and the viability of the contemporary procedures. With experiments showing no necessity for additives, others showing no detectable presence of additives historically, and still others showing that additives might have detrimental effects on the quality of the papyrus, the realistic possibility of adhesive glues and pastes seems less and less likely.

In the face of mounting evidence, some papyrologists have worked towards a compromise; they have attempted to reconfigure the interpretation of Pliny to adjust for historically and experimentally proven truths. Lewis states that Pliny may have been refering

to a varnish applied to papyrus to improve writing that was used during the fifth and sixth century (Papyrus in Classical Antiquity 67). However, this seems an unlikely interpretation because the varnish was not a paste, and would not have been useful for adhesive means. Another suggested interpretation–and one that has become somewhat popular–is that Pliny's description was in reference to the flour-based paste that was used in gluing the individual sheets together in the formation of the long papyrus scrolls (68). While this is a valid suggestion and is a very probable source of Pliny's confusion, the nature of the description refers to a paste rubbed into the papyrus as a whole. Pliny, who had never engaged, or even seen, the manufacture of papyrus, confused some of the steps in his explanation of the process. Pliny's mistake is justifiable and understandable. However, papyrologists unquestioning subscription in his system of knowledge for centuries is inexcusable.

Finally, it has recently been argued by Andrew Dimarogonas that while Pliny's justifications and explanations may be wrong, much of his process separate from justifications may be correct. While Dimarogonas readily admits that muddy water served no purpose as glue, he maintains that it is possible that it fulfilled another need. He feels that perhaps, the board on which the papyrus was laid was first moistened with clay-filled water. While not holding the strips together, the clay might act to hold the moistened strips to the board during the construction of the sheet. To corroborate his claims, Dimarogonas does a chemical analysis of Nile clay and papyrus from antiquity and finds that the chemicals in clay are found in prepared papyrus in substantial amounts (589-90). Dimarogonas takes a scientific method to help guide and shape his interpretation of the classical text in what is perhaps the safest and best way. By consider experimental, scientific, and historical results in the drafting of this theory, he is able to reconfigure his view of Pliny's text and retrieve valuable

corroborating evidence for his theory.

While not always possible, Dimarogonas' example is important in an analysis of our conception of historic "fact." By considering Pliny's text, by engaging in first-hand research and experimentation, by exploring the use of papyrus in the historical record, and by seeking chemical and scientific evidence before reevaluating the historic text, the historic "fact" begins to be reconfigured in a way is lent much more validity. Through an exploration utilizing these means, the conception that papyrus was fixed together with an added adhesive proves extremely unlikely. Equally important in understanding and avoiding this mistake are the reasons for this misconception.

Conclusions and General Comments

While the points argued in this paper are representative of misconceptions that are widely held in regards to the materiality of papyrology, the arguments surrounding papyrus are not limited to conceptions and images of quality, flexibility and durability and the presence or absence of additive adhesives. As exemplified in Pliny's description of papyrology that was widely held as truth for centuries, the exploration of the material aspects of papyrology has, in many ways, actually eliminated "knowledge" as it has progressed–we know less and less as we learn more. With the multi-disciplinary approach advocated in this paper, one that incorporates scientific, historic, and experimental approaches working in tandem, papyrologists become more justified in claiming historic truth in their work. The study of the materiality of papyrology exists between literature, history, science, and craft. Only an approach that incorporates all of these facets of study can hope to truly achieve validity in the field.

However, progression along these lines is very real. Knowledge as to the actual nature,

quality, and durability is well known and museums are exhibiting examples of papyrus that are strong, supple and durable as a slow but effective form of reeducation. Similarly, people who even up until 1971, clung to Pliny's description and argued against those who suggested that natural bonds alone might be sufficient in bonding papyrus layers have effectively disappeared. In 1988, Donald Ryan is able to nonchalantly throw out the statement that "we have since discovered that natural substances within the plant itself provided the necessary adhesive to bind the pressed strips into a single sheet of paper" (137). Fifty years previously, this statement would have released a firestorm of criticism. Through the continued manufacture of papyrus, continued historic examination, and continued scientific exploration, more of these debates will eventually be put to rest.

Appendix I

Figure 1. The papyrus plant will grow to between 5 and 15 feet tall. Only the peeled stalks will be used in the manufacture of writing materials.

Figure 2. Close up of the papyrus whole papyrus plant.

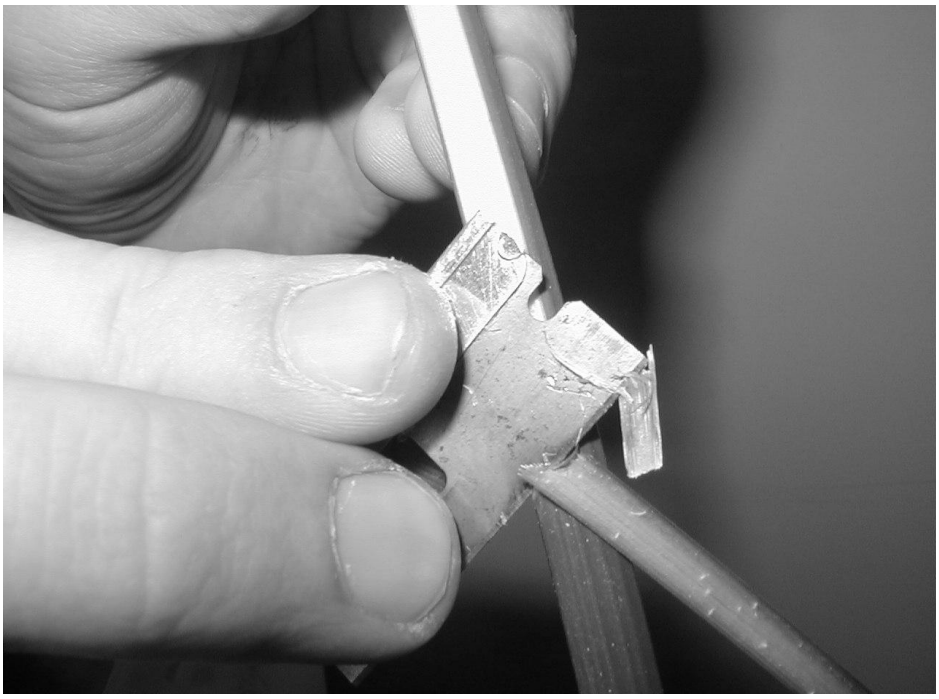

Figure 3. The green outer shell on the shaft is stripped.

Figure 4. The large majority of the plant is discarded as waste.

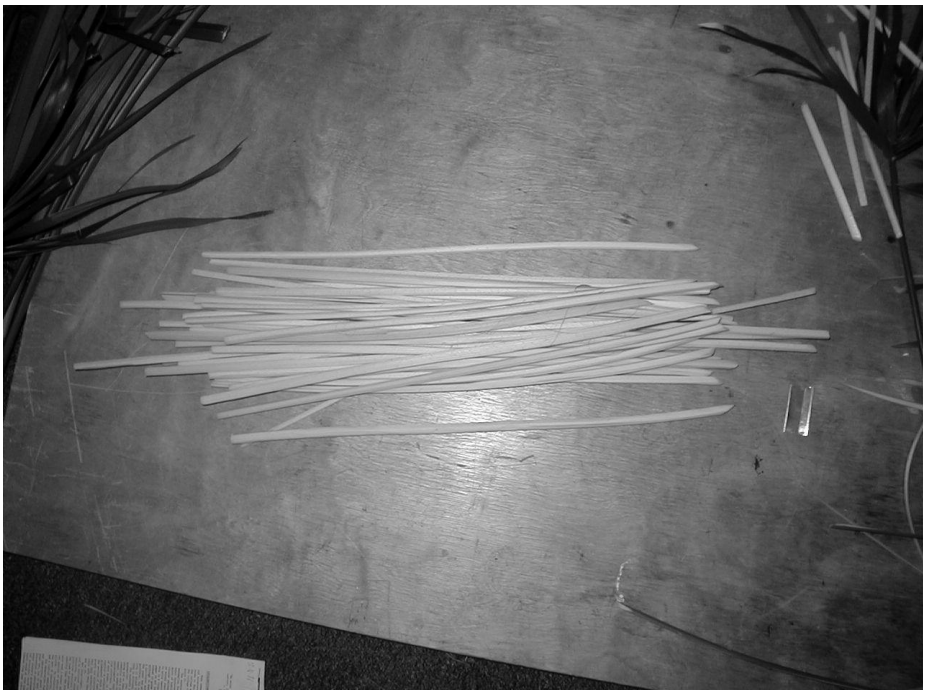

Figure 5. The stripped stalks are cut in half or into the desired size of the paper. Shown is about one piece of paper worth of stalks.

Figure 6. The stripped and cut stalks are cut into thin slices.

Figure 7. The cut, stripped, stalks are cut into strips and then pounded to break the fibers and remove moisture from the plant.

Figure 8. The pounded strips are soaked for three to six days to remove sugars from the plant.

Final Steps (See attached sheet of papyrus). The strips are laid out parallel to each other in two perpendicular layers on a piece of linen, pounded again, pressed, and then left to dry to in the sun for several days.

In my first attempt, the individual strips of papyrus shrunk and left gaps in the paper and did not sick to the layer below them completely during the drying process. I attribute this largely to the lack of a press (I improvised with boards and heavy objects) and proper pounding equipment. Research seems to imply that before presses, gums or glues may have been used to the hold the individual strips and layers together more effectively.

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