of these parallels, it seems to me that a *Pharia pristis* need not be a literal *pristis*, even if we assume that Ovid had any clear idea what the ichthyologists' *pristis* looked like. The crocodile is monstrous, predatory, scaly, predominantly aquatic, and conspicuously sawtoothed, as well as Egyptian, and that should be enough to permit Ovid to call it a *Pharia pristis*.[16] Readers who combine textual conservatism with a high tolerance for bold catachresis may wish to hold on to the *Pharius piscis* of the manuscripts.[17]

University of Alabama, Tuscaloosa MICHAEL HENDRY

PLINY THE ELDER ON THE MAKING OF PAPYRUS PAPER

Pliny the Elder in *Natural History*, xiii, 74–82,[1] described in detail specifications for the manufacturing of papyrus. However, there was a spurious omission pertaining to the height (the term *length* was also used by some authors) of the manufactured sheet in sentence 78. Johnson[2] has listed the different theories explaining this as an oversight or that a standard height-to-width ratio existed, thus making the specification of the height redundant. The latter is not substantiated by the measurement of the dimensions of extant papyrus rolls.[2] Johnson proposed a more rational theory, that it was most important to specify the width but this does not explain the absence of any specification of height, even as a measurement of secondary importance.

Because the resulting height was not exactly known in advance, Pliny clearly stated that the longitudinal layer ought to have *vertical* (longitudinal) *strips as long as possible* (sentence 74). Obviously, it was necessary to trim the excess height of the longitudinal strips after the lateral strips were laid. Close observation of the heights and widths listed in the Johnson paper reveals that the different sheets comprising a roll had nearly equal width but a great variety of rolls of different heights has been found (widespread, nearly Gaussian, statistical distribution with standard deviation 3.4 cm), corresponding to different field of application and the random width of the strips used. The sheet widths appear to have more consistent values (narrow statistical distribution, standard deviation 1.8 cm). The manufacturer could control closely either the height or the width. The latter was most important to be standardised to

[16] At first gland, *Phariae ... pestis* might seem attractive. We have seen (n. 8 above) that *pestis* is often confused with *pristis/pistris* and *piscis*. However, the word is much commoner than *pristis*, and so much less likely to be corrupted. More important, the description of a crocodile as a *Pharia pestis* would be accurate but insufficiently precise: although the crocodile is undoubtedly Egyptian and a *pestis*, the reference of the nouns is not specifically aquatic or sawtoothed, and *Pharia pestis* might just as easily describe the hippopotamus or the asp—perhaps even the ibis, if revolting habits count for anything. Ovid's reference to crocodilian cosmetics is already obscure enough with *pristis*. No doubt one reason for the obscurity of the expression is to help disguise the fundamental unpleasantness of the subject of crocodile dung.

[17] I wish to thank the editors for their help, particularly Stephen Heyworth for his suggestion about the meaning of *uirgis* and for convincing me that *tempora* was more likely than I had at first thought, among much other advice, welcome even when not heeded. I also wish to thank Spurgeon Baldwin, Kirk Summers, and Tatiana Summers for editorial advice, and Herbert Boschung, Jr. for help on the ichthyological side.

[1] Pliny, *Natural History*. Translated by H. Rackham (Heinemann/Loeb, 1938).

[2] Johnson, W. A., 'Pliny the Elder and Standardized Roll Lengths in the Manufacture of Papyrus,' CA, (1993), 46–50.

facilitate the work of the scribes, leaving the height to vary with the (random) widths of the strips used. Thus, Pliny describes the process accurately.

A related matter to the above discussion concerns Pliny's sentence 77, *Paper of all kinds is 'woven' on a board moistened with water from the Nile, muddy liquid supplying the effect of glue.* Many investigators, most cited extensively by N. Lewis,[3] made experiments of papyrus making which showed that papyrus can be manufactured without glue because its-own liquids act as gluing agents[4] or that physical bonding between the papyrus strips is strong enough to keep them together and no glue is necessary.[5] Wiedemann and Bayer[6] have reported extensive photomicrographic and chemical analyses of numerous sections of ancient papyri which clearly revealed the existence of starch between the two layers. Hepper and Reynolds[4] reported experimental proof that the papyrus pith did not contain starch. Therefore, starch was used during the papyrus manufacturing. Wiedeman and Bayer further reported that specimen taken from papyri after the third century B.C. showed that the practice of using starch glue was discontinued after that time. Because the manufacturing of papyrus most probably was controlled by the state[7] it is highly probable that at a later time, before Pliny wrote his Natural History, the practice of using starch glue was generally discontinued. This might be related with the introduction of the beam press. This might explain the ambiguity in the Pliny's description of the use of starch glue in the papyrus manufacturing.

While using muddy water as glue seems absurd, the mud may have fulfilled another need. In sentence 77, Pliny simply meant exactly what he wrote: the board on which the papyrus strips were laid, was moistened first with Nile water containing clay. Wet clay is known to be sticky and simply helped holding the strips on the board during the making of the papyrus sheet. Otherwise, the precise position of the two layers of strips could not be maintained, especially in conditions of regular production and not laboratory manufacturing of a single sheet only by the scholars who tried to disprove sentence 77. Moreover, in the manufacturing of writing paper inorganic matter is used as a filler in order to reduce the paper's absorptivity of ink. Such substances are clay, rosin, alumina, titanium oxide, etc. This suggests the strong possibility of an additional purpose of what is described in sentence 77, that muddy water was used for the papyrus manufacturing: to make it more dense, thus less absorbent. There is proof for the existence of clay in papyrus. Clay is known to conform nearly to the composition $Al_2O_3,2SiO_2,2H_2O$. Löverstam and Swietlicki[8] used PIXE analysis and imaging to obtain chemical analyses of ancient papyri but they did not report detailed results. Lucas and Harris[9] reported the chemical composition of clay from the Nile:

[3] Lewis, N., *Papyrus in Classical Antiquity*. (Oxford, 1974).

[4] Hepper, F. N., Reynolds, T., 'Papyrus and the Adhesive Properties of its Cell Sap in relation to Papermaking', *J. Egyp. Arch.*, 53 (1967), 156–7. Reynolds, T., 'Adhesive Substances in *Cyperus papyrus* L.', *Chem & Ind.*, April, 29 (1967), 704–5.

[5] Ragab, H., 'A New Theory Brought Forward About the Adhesion of Papyrus Strips', *14th Int. Congr. of Paper Hist.*, Manchester, (1978). Quoted in Wiedeman and Bayer, loc. cit., not available to this author.

[6] Wiedeman, H. G., Bayer, G., 'Papyrus: The paper of Ancient Egypt', *Anal. Chem.*, 55, no. 2, (1983), 1220A–1230A.

[7] Hunter, D., *Papermaking, the History and Technique of an Ancient Craft*, 2nd ed. (Knopf, 1947); Casey, J. P. (ed.), *Pulp and Paper: Chemistry and Chemical Technology*, 3rd ed. 4 volumes (Wiley, 1983).

[8] Löverstam, N. E. G., Swietlicki, E., 'PIXE Analysis and Imaging of Papyrus Documents', *Nuclear Instruments and Methods in Physics Research*, B45 (1990), 307–10.

[9] Lucas, A., Harris, J. R., *Ancient Egyptian Materials and Industries*, 4th ed. (Arnold, 1962).

aluminium oxide 14.8% and silica 43.1%, which is equivalent to aluminium 7.7% and silicon 20.11%. Wiedeman and Bayer gave the chemical composition of samples taken from several old papyri without discussing the implication, which is very substantial. Table I of the Wiedeman and Bayer paper gives the chemical composition of ancient papyri and the one for recently manufactured papyrus, the latter without glue or clay, for comparison. The large content of aluminium and silicon (4.05 and 7.15%, respectively) in the ancient papyri clearly indicates the existence of clay in substantial quantity. In the fresh papyrus, the aluminium and silicon content is insignificant (respectively, 0.009 and 0.54%). Obviously, clay was used in the manufacturing of ancient papyrus and Pliny's description of the use of the muddy water of the Nile is independently confirmed.

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DON'T TRY THIS AT HOME: PLINY'S SALPE, SALPE'S *PAIGNIA* AND MAGIC

There are two women called Salpe who are said to have written books in antiquity: one is described by Athenaeus (7.322a) as the name or pseudonym of a writer of '*Paignia*', the other is cited by Pliny the Elder who calls her at one point Salpe obstetrix. Salpe is a rare name in antiquity—I know of no other examples—and few ancient books were ascribed to women. That two of these rare female writers should be called by the same name is something of a coincidence. That the name they shared was the very rare Salpe is *a priori* distinctly unlikely.[1] It is much more plausible that they were one and the same.

The first secure mention of Salpe seems to be in a fragment of Nymphodorus of Syracuse a writer of *Periploi*, tentatively dated to the third century B.C.[2] Athenaeus preserves a fragment of his '*Periplus* of Asia' in which he insists that far from being a nickname for one Mnaseas of Locri or Colophon, 'Salpe the author of the *Paignia* was a Lesbian woman'.[3] There is little or no information as to the content of the work, although it has widely been assumed that it would have been erotic or pornographic,

[1] Wilamowitz noted the coincidence, but found it no more than 'spaßhaft', suggesting Salpe was a fictitious name used as a *nom de plume*, although, in fact, Athenaeus' comments suggest there was only one work of *Paignia* ascribed to Salpe in antiquity, and that some considered the name to be a pseudonym of Mnaseas, and others of a Lesbian woman, U. von Wilamowitz-Moellendorf, *Hellenistische Dichtung* I (Berlin, 1924), p. 83 n. 2. It should perhaps be pointed out that the saupe, the fish from which she took her name, was usually considered an unattractive shit-eating animal, and the nickname was unlikely to have been coined for the sake of flattery, see Wilkins and Hill ad Archestratus F 28.

[2] *FGrHist* 572 F 5. Jacoby (ad Alcimus, *FGrHist* 560 F 1) thought that the discussion of Salpe had been lifted by Athenaeus wholesale from Apollodorus' ten-volume commentary *On Epicharmus*. Nymphodorus' dates are discussed in Jacoby's introduction to the author, where he follows Laqueur in giving a floruit at the end of the third century, or in the last thirty or so years at any rate (p. 603). There is also a reference to Salpe in a passage ascribed by Athenaeus to Alcimus, a historian Jacoby dates to the early fourth century. If this is regarded as an original part of Alcimus' text, Salpe's dates can be pushed back much further, although Jacoby himself discounts this possibility and brackets the reference in his text of the fragment.

[3] Both Wilamowitz (loc. cit.) and Jacoby (ad 560 F 1) seem unduly sceptical about the existence of Nymphodorus' Lesbian woman, although women are more highly represented among the erotic and medical/magic genres than elsewhere. Salpe would be in the good company of Lais, Elephantis and Philaenis, whose work was also suspected of having been written by a man.