Comment on "30,000-Year-Old Wild Flax Fibers"
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Comment on "30,000-Year-Old Wild Flax Fibers"

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Kvavadze *et al*. (Brevia, 11 September 2009, p. 1359) identified fiber samples as 30,000-year-old flax based on a comparison with modern flax fibers analyzed by compound microscope and on the presence of dislocations/nodes in the fibers. We argue that this evidence is not sufficient to identify the fibers as flax.

Kvavadze *et al*. (*1*) recently described fiber samples found in a series of Upper Paleolithic layers at Dzudzuana Cave in Georgia. Based on radiocarbon (^{14}C) dating of accompanying material (bone and charcoal), the authors dated the fibers to 30,000 years ago. The authors also report that the fiber samples are flax based on comparison of white light compound microscope images of the samples with (i) similar images of modern flax, (ii) scanning electron microscopy images of modern flax, and (iii) an interference microscopy image of an ancient sample reported to be flax. The authors claim that "some of the characteristic features of the flax fibers structure are their considerable thickness" and that "they consist of multiple longitude segments" [Supporting Online Material (SOM) for (*1*)]. Kvavadze *et al*. further state that "[a]pplying these criteria, flax fibers are easily separated from other plant fibers" [SOM for (*1*)]. Unfortunately, this statement is not correct. Although it is easy to distinguish cotton from flax [by polarization microscopy (*2*), for example], it can be very difficult to distinguish between different types of bast fibers. Bast fibers can be extracted from plant stalks or tree bark (cotton is not a bast fiber). Bast fibers have a characteristic cross-section appearance with a central opening (lumen) surrounded by the cell wall (*3*). Bast fibers used for textiles include flax, hemp, nettle, ramie (an Asian nettle variety), jute, and more rarely, wood. Flax tends to have a smaller overall diameter and a smaller lumen than other bast fibers. This is often a very good indicator for identification. However, the flax lumen is not always narrow, and other bast fibers can show narrow lumen too, so this is not a conclusive identification criterion (*4*). A comparison of thickness measurements of several types of bast fibers, including flax, show that the overlap is so large that thickness cannot be taken as a conclusive criterion [see for example (*4*, *5*)].

The "multiple longitude segments" Kvavadze *et al*. mention are the areas of the fibers located between what is normally referred to as dislocations, nodes, or kinks (*6*). The first description of dislocations is attributed to von Höhnel (*7*), who described "ring markings" as a result of "tension in the tissues." The cause(s) of dislocations are still debated, but they are common in many plant fibers. Catling and Grayson (*4*) write that "Whatever the cause, there is no doubt that dislocations occur in every species examined during the course of this work." As early as 1957, Tobler (*8*) noted that "the significance of dislocations for diagnostic purposes has completely disappeared" [see also (*6*, *9*)].

Kvavadze *et al*. state that another important diagnostic property is the particular structure of the fiber extremities, noting that those of flax fibers are "completely straight (as if truncated)" [SOM for (*1*)]. However, Catling and Grayson (*4*) present images of fiber cell ends for a range of plants. They showed 11 different ends for flax alone and concluded that these ends are not a useful character for the identification of plant fibers. Kvavadze *et al*. finally state that "[t]he structure of the flax fibers is linear, while that of cotton is smooth" [SOM for (*1*)]. By "linear," we assume they are referring to the fact that the fibers are not round but have a polygonal cross section. This cross-sectional shape can, however, also be found in many other bast fibers. Herzog (*5*), for example, writes that "based on the experience of many years I would not ascribe the cross section appearance of flax the importance of a characteristic or distinguishing feature (the same applies to hemp)."

For the reasons explained above, white light compound microscopy alone is not a failsafe method for identifying flax fibers. The presence of a lumen and the dislocations in the fiber samples only provide evidence that they are bast fibers. The fiber samples may be flax, but they have not been proven to be so. As an illustration, Fig. 1 shows white light and polarization microscopy images of modern domesticated flax (*Linum usitatissimum*), nettle (*Urtica dioica*), and hemp (*Cannabis sativa*) fibers, respectively. The similarity between these fiber images and the images of the fiber samples published in (*1*) is evident.

We contend that for a conclusive identification of flax, other analytical methods are necessary. An ideal method would be DNA analysis, but it is generally difficult to extract DNA even from modern bast fibers (*10*). The removal of the fibers from the plant stem (retting) involves exposure to water, thus increasing the likelihood of extensive hydrolytic damage to the DNA (*11*, *12*). The presence of crystals in the associated tissue of the fibers can provide clues to their identity. For example, calcium oxalate crystals are present in ramie and hemp but not in flax (*4*). Polarization microscopy can also be used to separate hemp from flax, nettle, and ramie based on the microfibrilliar orientation (*13*). A conclusive method for identifying flax fibers that works well even with very little fiber material is x-ray microdiffraction. This method can identify very slight species-dependent differences in the cell wall structure, including the organization of well-oriented cellulose fibrils. It often works well even on damaged fibers, in which degraded surface features can obscure the results of light and electron microscopy. Müller *et al*. (*14*) were the first to apply this method to plant bast fibers. They successfully identified flax and ramie (and also, unexpectedly, cotton) fibers from caves of the Dead Sea region. For a further discussion of characterization criteria for bast fibers, we also refer to (*15*).

In conclusion, Kvavadze *et al*. (*1*) present white light compound microscopy images of fiber samples with a clearly visible lumen and dislocations. Based on these two features, the fiber samples can be identified only as bast fibers. Any further conclusions about the nature of these fibers will require additional investigations with other techniques.

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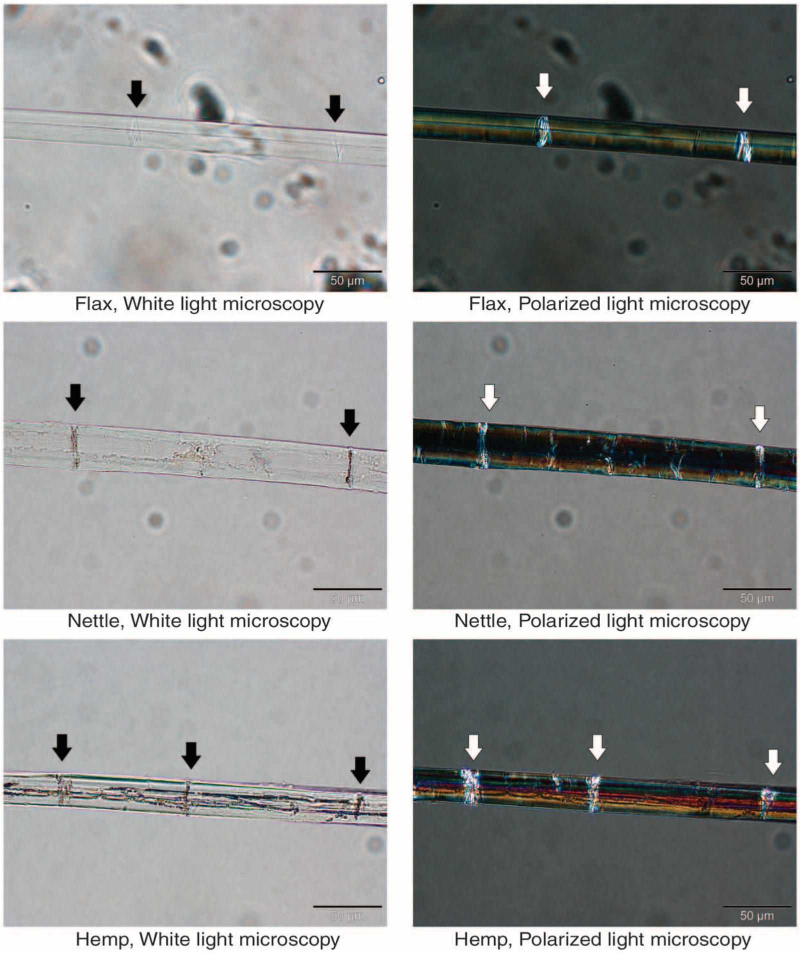

Fig. 1. Images of modern fibers from flax, nettle, and hemp acquired with an Olympus BX-51P compound microscope. Dislocations (arrows) are clearly visible in all three fibers. Note the narrow lumen in flax. This is typical but does not always occur. The polarized light images were taken with the analyzer and polarizer perpendicular to each other.

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