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Citation	Kvavadze, Eliso, Ofer Bar-Yosef, Anna Belfer-Cohen, Elisabetta Boaretto, Nino Jakeli, Zinovi Matskevich, and Tengiz Meshvelinai. Forthcoming. Response to comment by Bergfjord et al. Science.
Published Version	http://www.sciencemag.org/
Accessed	February 18, 2015 3:38:42 PM EST
Citable Link	http://nrs.harvard.edu/urn-3:HUL.InstRepos:4064022
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Response to comment by Bergfjord *et al.*

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Abstract

The comment by Bergfjord et al. expresses doubts concerning the possibility of identifying flax fibers on the basis of the morphology of their internal layers. The authors use microphotographs and descriptions of the outer layers of fibers as arguments for their claims. Morphology and structure of the outer and inner parts of fibers are radically different, and for that reason the methodological approach of Bergfjord et al. is questionable.

The identification of flax fibers in our study (1) is based on the morphology of the internal layers of fibers, exposed due to the chemical treatment applied for palinological sample preparation. This morphology is significantly different from the structure of the outer layers of the flax fibers. The fibers surface is not smooth anymore, but rather linear. Each flax fiber consists of multiple segments of equal length. The segments are always clearly visible, and appear distinctly separated from each other by deep linear grooves. The structure of these short fiber segments is always linear, and their ends are straight as if cut across. The results are tested by experimental work at the laboratory with recent plant material. Exposure of the internal structure of modern flax fibers was achieved experimentally subjecting the fibers to damage procedures analogous to the treatment of the palinological samples by chemically active substances such as potassium hydroxide, acetic anhydride, sulphuric acid, and others.

Following these procedures a range of new taxonomic characteristics was defined. These features are missing in the outer layers of fibers, but can be successfully used for

identification of fossilized plant fibers. They were observed by us during the study of more than a thousand of modern flax samples, as well as several thousands of ancient ones. The next step of our studies was a comparison of the internal structure of flax fibers with the structure of other plant fibers. Those were nettle, hemp and cotton, *i.e.*, species most commonly used for textile production. The comparison has shown clear differences in the morphology of the inner layers of each of the plants, as clearly visible on Fig. 1. In nettle fibers, the segments are of uneven length, and they lack deep grooves with straight borders. The internal structure of hemp is generally not segmented. Also, the surface morphology is different, and fiber extremities are not straight. Thus, our results are in accordance with the authors opinion that the internal structure of fibers (similarly to other vegetative or generative parts of plants) is the most reliable criterion for their identification **(2, 3)**.

We cannot agree with the conclusion of Bergfjord et al. (4) that light microscopy does not allow the identification of bast fibers. The history of the textile fibers research proves the opposite. Light microscopy always revealed the main characteristic traits of the fiber morphology and allowed plant identification (5-6). Applying palynological research methods for the study of archaeological material (3, 7-10), including archaeological textiles (11) proved to be an efficient tool for identification and examination of all kinds of fibers. For instance, in the study “Fibers of silk, cotton and flax in a weaving workshop from the first century A.D. palace of Dedoplis Gora, Georgia” (12) fibers of flax, hemp, cotton, rush and silk were identified. Micro-remains of flax, cotton and jute were identified during the study of samples from the Samtavisi Basilica (11). Fibers of wool textile were also identifiable in the archaeological material (8). Therefore we consider treating textile fibers as a palynomorph a most promising method for archaeological research.

The use of other methods, such as DNA analysis, X-ray micro-diffraction, polarization microscopy is undoubtedly profitable for the verification of the obtained results. They would help also in the identification of so far unidentified fibers represented in the material from Dzudzuana cave as well as other archaeological sites.

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Fig. 1: Modern fibers: 1 – flax, 2 – hemp, 3 – nettle.

