IGERT Highlight 2008/2009

Phylogenetic Analysis of Early Human Writing Systems: Quantitative Analysis of Proto-Cuneiform

IGERT 0504487, Dynamics of Communication in Context, University of Pennsylvania

Christina Skelton, IGERT trainee and linguistics graduate student at the University of Pennsylvania, has recently developed a novel research program to study the origin and progression of early writing systems that arose in southern Mesopotamia around 3400 BCE. Using excavated written tablets from the region, she has begun to quantify the evolution of sign-form variations using phylogenetic systematics, a method first developed in the biological sciences for reconstructing 'family trees' of related organisms.

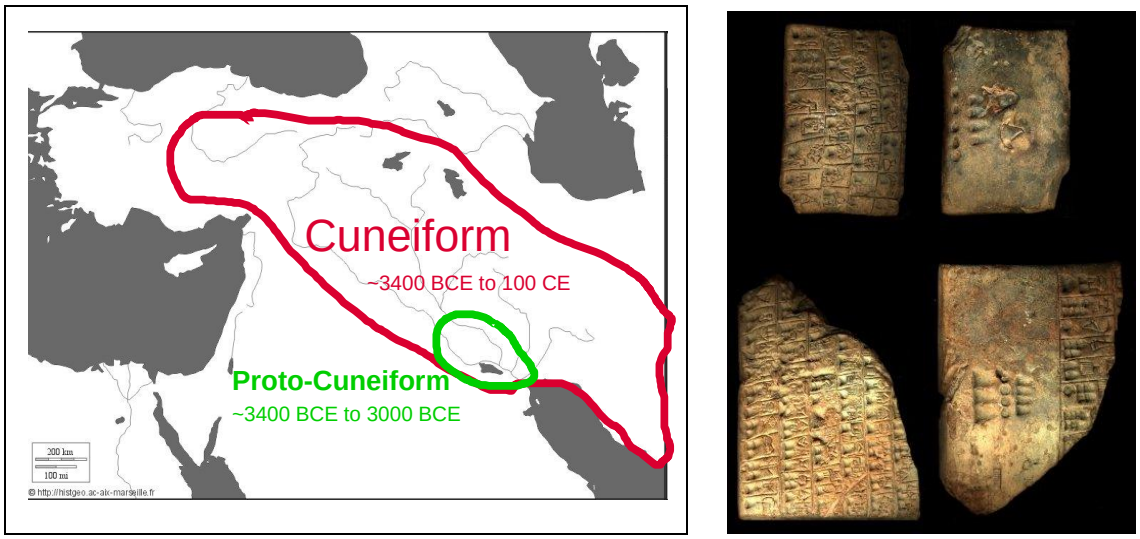

Figure 1. Map of the region known as the Fertile Crescent (Left), considered the cradle of early human civilization. The earliest known writing system, Proto-Cuneiform originated around 3400 BCE in southern Mesopotamia. Examples of early Cuneiform tablets (Right). Source: CDLI (http://cdli.ucla.edu/wiki/lib/exe/detail.php/images/lateuruk03.jpg?id=proto-cuneiform&cache=cache) .

Skelton's work is part of a larger research and education effort at The University of Pennsylvania to establish itself as a leader in the emerging interdisciplinary field of Language and Communication Sciences. Skelton's academic and field training are being administered under the direction of her advisor, Penn Professor Don Ringe, renowned expert in the field of historical linguistics. Skelton's traineeship is supported by The University of Pennsylvania's graduate training program in Language and Communication Sciences (LCS), funded by an Integrative Graduate Education and Research Traineeship (IGERT) grant from the National Science Foundation (IGERT 0504487, *Dynamics of Communication in Context,* PI: Trueswell). This IGERT program brings together students and faculty from diverse backgrounds and expertise who share an interest in understanding the computational and neural underpinnings of linguistic and nonlinguistic communication.

The primary ambition for this IGERT is to create a community of scholar-scientists with the conceptual reach and technical expertise to integrate the computational, cognitive and neuroscientific study of communication, be it characterized as human-linguistic, animal or machine. By bringing together faculty and students with such diverse skill sets, we hope to produce a new generation of scholars with unique combinations of expertise that make them not only special in their own sub-discipline but relevant to a larger community, by creatively combining ideas, techniques and analyses in ways previously not considered.

The world's first true writing system, proto-cuneiform, arose in the fertile land of southern Mesopotamia around 3400 BCE. It flourished for four hundred years in mud-brick cities such as Uruk, famous as the setting of the Epic

of Gilgamesh, and established the basic structures for information processing and the graphical representation of linguistic information that are the basis for nearly every subsequent literate society, including our own. The invention of proto-cuneiform was more than the invention of a new tool; it was one of the most profound conceptual revolutions in the history of humankind.

Unfortunately, our understanding of how proto-cuneiform arose and developed is hindered by the lack of archaeological context for the tablets. Many deposits of tablets were used as fill in contemporary building projects; others appeared on the antiquities market with no locality or dating information. The result is that it has been very difficult for researchers to systematically analyze the development of proto-cuneiform and how it changed over time into other writing systems.

Skelton's research stands to radically change this situation. Together with her collaborators, Skelton has taken advantage of the fact that sign-forms changed over time and differed between scribes, as new scribes learned from older scribes. Skelton has begun track the evolution of sign-form variations quantitatively, using phylogenetic systematics. In evolutionary biology, this method is used to construct 'family trees' that show the relations and patterns of descent among types of organisms. Phylogenetic methods have also been successfully applied to the evolution of languages and copies of manuscripts. As a first test case for this method, Skelton adapted phylogenetic methods to the study a more recent writing system, Linear B, a pre-alphabetic Greek writing system that already had fairly good archeological records.

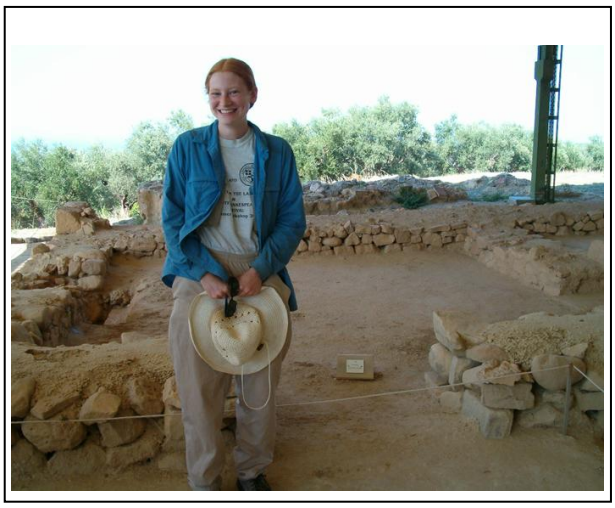

Figure 2. Christina Skelton standing outside the Archives Room in the Mycenaean palace of Pylos, where many clay tablets bearing Linear B script were found. (Photo courtesy of Christina Skelton.)

Skelton chose a set of scribal hands from different sites where Linear B tablets are attested. These scribal hands were treated as 'taxa', and the set of similarities and differences between them, which represent variations in the way they wrote Linear B characters, were then treated as ''phylogenetic characters.' Using a phylogenetic analysis, Skelton was able to generate a 'family tree' that successfully reconstructed the evolution of the Linear B writing system (see Figure 3).

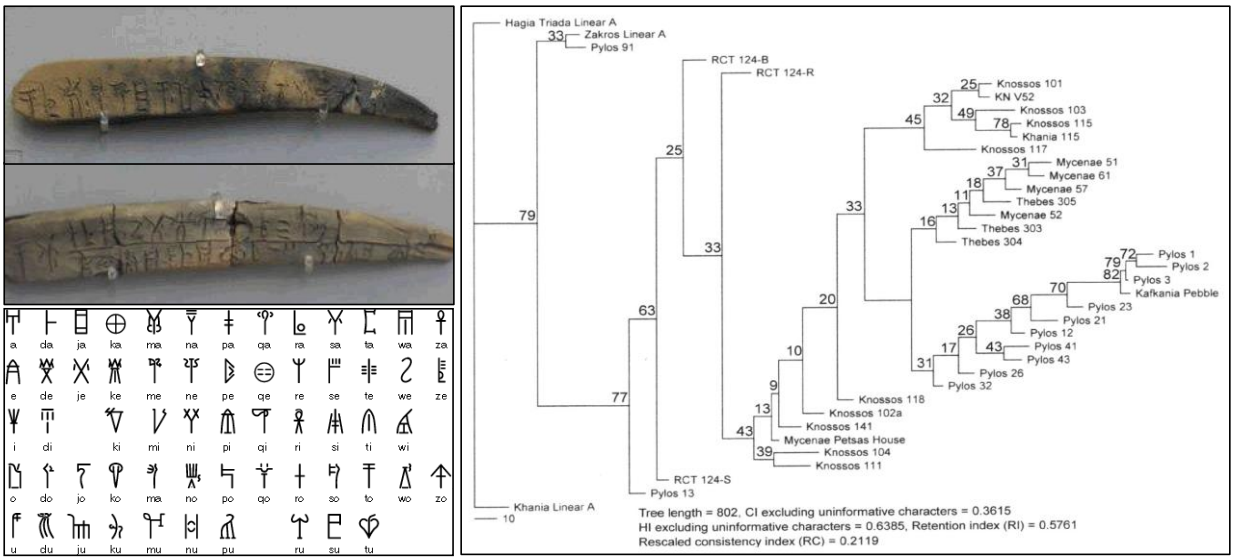

Figure 3. Examples of Linear B tables (upper Left) and examples of the Linear B symbols (lower right). The results of Skelton's Phylogenetic analysis of Linear B Tablet symbol feature changes, which document how various tablet sites are related and organized over time. (Photo courtesy of C. Skelton. Tree diagram from Skelton (2008, *Archaeometry*, Vol. 50, pp. 158–176). Linear B chart comes from http://www.omniglot.com/writing/linearb.htm).

Since her initial work on Linear B, Skelton has started to apply her analyses to earlier proto-cuneiform tablets. During the Summer of 2008, Skelton visited the Max Planck Institute for the History of Science in Berlin, where she gathered data on five variations in one proto-cuneiform sign, EN-a, in eight deposits of proto-cuneiform tablets. The source for her data was the Cuneiform Digital Library Initiative, a searchable online digital library of cuneiform tablets, including scanned images, drawings, and transcriptions of tablet tests. Skelton's phylogenetic analysis produced a tree of proto-cuneiform roughly consistent with what little archaeological context we have for the deposits of tablets in question, showing that this proof-of-concept was successful. In the future, she hopes to include data from more proto-cuneiform signs and more deposits of tablets in order to shed further light on the development of the world's first writing system.

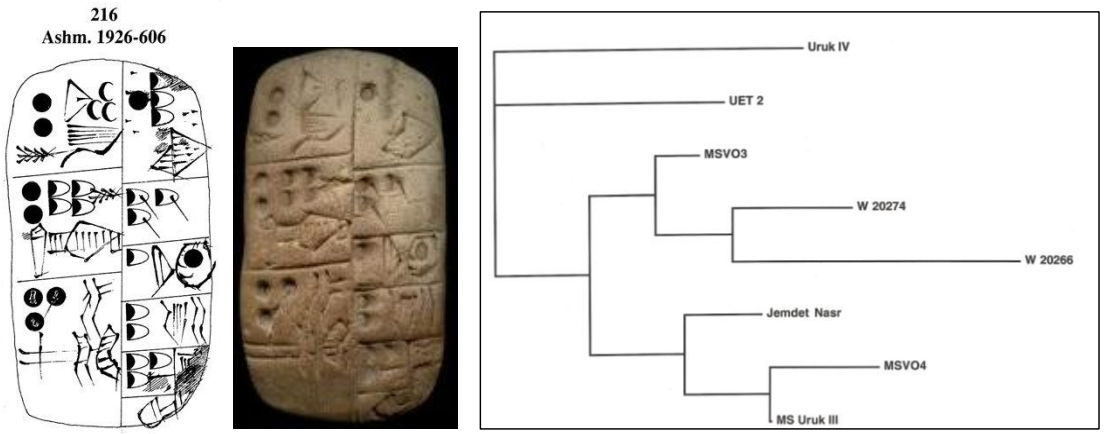

Figure 4. Example of an early proto-cuneiform tablet (left). The results of Skelton's Phylogenetic analysis of proto-cuneiform (right), which hypothesize how various tablet sites are related and organized over time. The tablet drawing and photo are from the CDLI; the diagram is a part of Skelton (unpublished).

Skelton's work has many levels of importance. In addition to documenting the emergence of the first written language, the work brings a new quantitative tool to the study of written language and language change. This tool, in the right hands, will help researchers understand how the human mind was capable of creating a written symbolic system -- arguably one of the greatest technological achievements in human history. The University of Pennsylvania IGERT program in Language and Communication Sciences is designed to offer the experimental, observational, and quantitative skills necessary to tackle this important research endeavor.