REPORT

HUMAN GENETICS

Ancient DNA from Mesopotamia suggests distinct Pre-Pottery and Pottery Neolithic migrations into Anatolia

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We present the first ancient DNA data from the Pre-Pottery Neolithic of Mesopotamia (Southeastern Turkey and Northern Iraq), Cyprus, and the Northwestern Zagros, along with the first data from Neolithic Armenia. We show that these and neighboring populations were formed through admixture of pre-Neolithic sources related to Anatolian, Caucasus, and Levantine hunter-gatherers, forming a Neolithic continuum of ancestry mirroring the geography of West Asia. By analyzing Pre-Pottery and Pottery Neolithic populations of Anatolia, we show that the former were derived from admixture between Mesopotamian-related and local Epipaleolithic-related sources, but the latter experienced additional Levantine-related gene flow, thus documenting at least two pulses of migration from the Fertile Crescent heartland to the early farmers of Anatolia.

Previous work has documented the existence of highly differentiated Neolithic populations in ancient West Asia (*1*–*9*) and some of their pre-Neolithic antecessors in the Caucasus (*10*), Iran (*1*, *11*), Anatolia (*6*), and the Levant (*1*). To anchor our integrative genomic history of the Southern Arc, a region we define as including Anatolia and its neighbors in Southeastern Europe and West Asia (*12*), we sought to understand how the earliest Neolithic populations were formed, with a particular focus on the Pre-Pottery period of Northern (or Upper) Mesopotamia, the area between the Tigris and Euphrates rivers of Southeastern Turkey, Northwestern Iraq, and Northeastern Syria, within the Pre-Pottery Neolithic interaction sphere (*13*). Despite the centrality of Mesopotamia in the archaeological record of the origin of farming (*14*), no genome-wide ancient DNA data from early Mesopotamian farmers has been published. We used in-solution enrichment for ~1.2 million single nucleotide polymorphisms (SNPs) to study Pre-Pottery Neolithic farmers from the Tigris side of Northern Mesopotamia: one from Boncuklu Tarla near Mardin in Southeastern Turkey and two from Nemrik 9 in Northern Iraq. We also report the first Pre-Pottery Neolithic data from Cyprus, an island to the south of the Anatolian peninsula and west of the Levant, which witnessed the earliest maritime expansion of Pre-Pottery farmers from the Eastern Mediterranean; our data come from three individuals whose fragmentary remains were found in a Neolithic disused and filled-in water well at Kissonerga-Mylouthkia (*15*). Furthermore, we report the first ancient DNA data from the Neolithic of Armenia, from two individuals buried at the sites of Masis Blur and Aknashen in the sixth millennium BCE. These individuals represent an inland Pottery Neolithic population, which we could compare to the Pre-Pottery one from Northern Mesopotamia to its south, the Pottery Neolithic one of Azerbaijan to its east (*7*), and later Chalcolithic individuals from Armenia (*1*). Finally, we sampled three Pre-Pottery Neolithic farmers from the Northern Zagros at Bestansur and the Zawi Chemi component of Shanidar cave in Iraq, who fill a gap between the more western and northern individuals and published data from the Central Zagros in Iran (*1*).

Details of the newly sampled individuals can be found in (*12*), and their geographical and

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Connecting genes and history

Stories about the peopling—and people—of Southern Europe and West Asia have been passed down for thousands of years, and these stories have contributed to our historical understanding of populations. Genomic data provide the opportunity to truly understand these patterns independently from written history. In a trio of papers, Lazaridis *et al*. examined more than 700 ancient genomes from across this region, the Southern Arc, spanning 11,000 years, from the earliest farming cultures to post-Medieval times (see the Perspective by Arbuckle and Schwandt). On the basis of these results, the authors suggest that earlier reliance on modern phenotypes and ancient writings and artistic depictions provided an inaccurate picture of early Indo-Europeans, and they provide a revised history of the complex migrations and population integrations that shaped these cultures. —SNV