

Genomic Stratigraphy of the Northwest Caucasus: Maeotian-Sindian Ethnogenesis and the Circassian Continuum (2018–2025)

1. Executive Summary

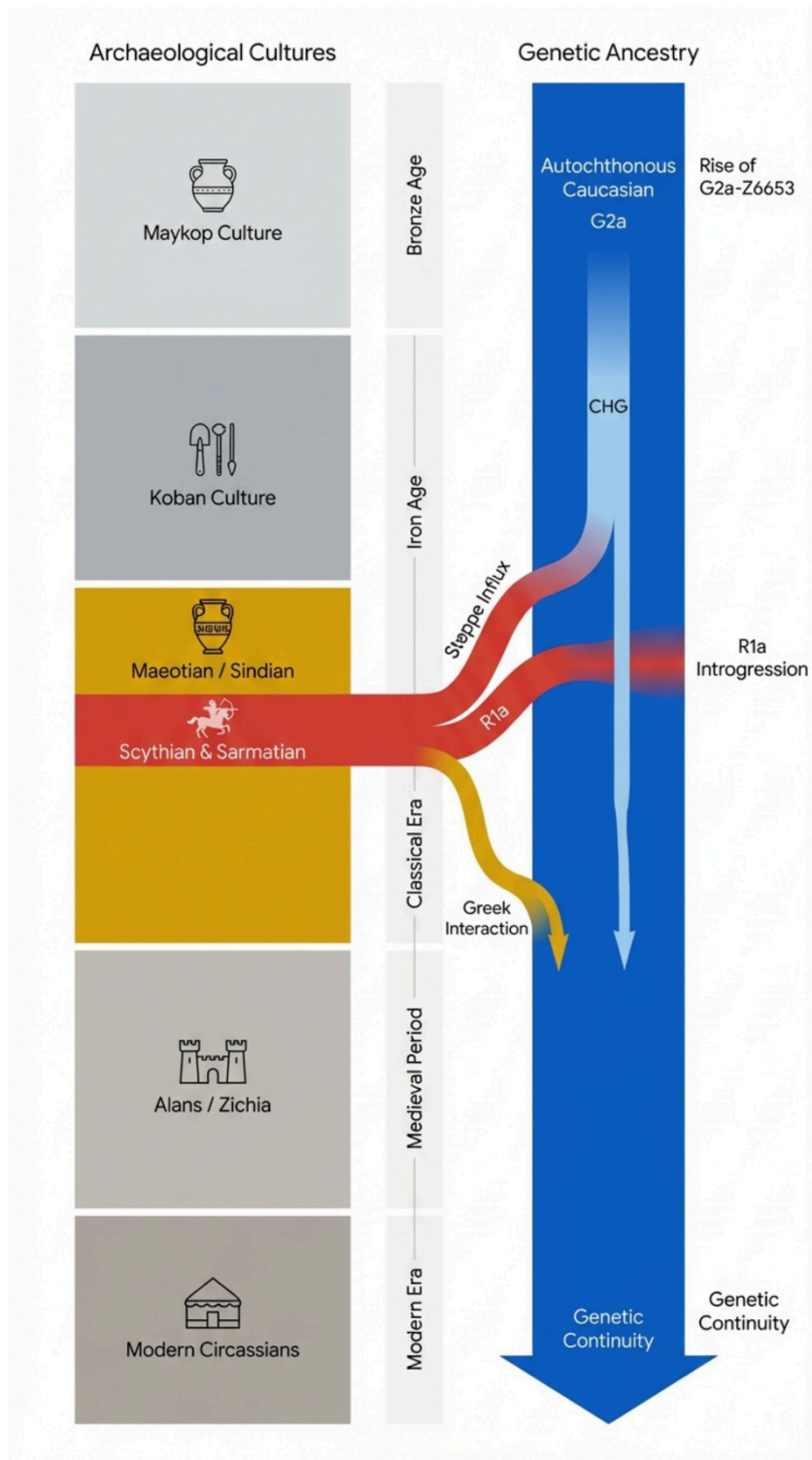
The paleogenetic reconstruction of the Iron Age Northwest Caucasus has undergone a fundamental paradigm shift between 2018 and 2025, driven by the proliferation of high-coverage ancient DNA (aDNA) datasets. For decades, the archaeological narrative of the Pontic-Caspian steppe and the Kuban piedmont was dominated by the "Scythianization" model. This paradigm posited that the material homogenization observed across the Eurasian steppe belt implied substantial demographic replacement or, at the very least, pervasive biological admixture between incoming Iranian-speaking nomads—primarily Scythians and Sarmatians—and the indigenous sedentary populations of the Kuban region, known collectively as the Maeotians (including tribes such as the Sindi, Kerkets, and Toreats).

However, recent genomic evidence, culminating in the landmark study *Genetic history of Scythia* by Andreeva et al. (2025) ¹ and complementary work on the Koban culture by Boulygina et al. (2020) ³, has systematically dismantled the assumption of demographic uniformity. Current data indicates that the Maeotians maintained a genetic profile strictly distinct from the nomadic groups that dominated the distinct ecological niche of the open steppe. While the Scythian gene pool is characterized by a dynamic admixture of Late Bronze Age Steppe ancestry (Srubnaya/Andronovo) with significant and increasing East Eurasian (Siberian) influxes over time, the Maeotian genomic signature exhibits a remarkable resilience and continuity with the autochthonous Bronze Age populations of the North Caucasus, specifically the Koban and Maykop cultures.

This report synthesizes genomic data from over 150 ancient individuals, focusing on the distinct haplogroup distributions—specifically the predominance of Haplogroup G2a and distinct clades of J2a in the indigenous groups versus the R1a-Z93 lineages ubiquitous among the nomads. We provide a detailed analysis of autosomal admixture profiles that highlight the absence of the "Siberian wedge" in the Maeotian population, a defining feature of the Scythian horizon. Special attention is paid to the interface sites of Semibratnee (ancient Labrys) and Gorgippia (Anapa), where the Bosporan Greek influence created a complex bio-archaeological stratigraphy that masked an underlying indigenous genetic persistence. The data confirms that modern Circassians (Adyghe) represent the direct biological descendants of these Maeotian populations, preserving a deep reservoir of Caucasus Hunter-Gatherer (CHG) ancestry that has remained largely resilient to the demographic

turnovers of the Great Migration Period.

Chronostratigraphy of the Northwest Caucasus: Genes vs. Material Culture



Comparative timeline of the Northwest Caucasus (3000 BCE – Present). The left stream illustrates the succession of archaeological cultures and dominant political powers. The right stream depicts the genetic continuity of the autochthonous North Caucasian population, highlighted by the persistence of the G2a Y-haplogroup and CHG autosomal component, contrasting with the episodic genetic influxes from Steppe nomads (R1a, East Eurasian admixture).

2. Introduction: The Maeotian Question in Paleogenetics

The Maeotians occupy a liminal space in classical historiography and archaeology, situated at the geographic and cultural crossroads of Europe and Asia. Described by Strabo and confirmed by epigraphic evidence from the Bosporan Kingdom, the Maeotians were not a monolithic entity but a confederation of sedentary tribes—including the Sindi, Dandarioi, Toreats, Psesoi, and Obidiakenoi—inhabiting the eastern shores of the Sea of Azov (Palus Maeotis) and the fertile basin of the Kuban River.⁵ Their territory served as a buffer zone between the expansive Greek colonization of the Black Sea coast, epitomized by the Bosporan Kingdom, and the nomadic pressure of the Eurasian Steppe exerted by Cimmerians, Scythians, and later Sarmatians.

Archaeologically, the "Maeotian culture" is defined by a specific suite of material traits: gray-clay pottery produced on a potter's wheel, extensive fortified settlements (*gorodišče*) located on high river banks, and a burial rite involving kurgans (*tumuli*) that often contained horses or horse harness equipment.⁵ This latter trait, along with the prevalence of the "Scythian triad"—weapons (*akinakes*, trilobate arrowheads), horse harness, and animal style art—in Maeotian elite burials, led early 20th-century scholars to debate the ethnolinguistic affinity of the Maeotians. Were they a sedentary branch of the Iranian-speaking Scythians, or were they an indigenous Caucasian population that had adopted the prestigious military technology and artistic lexicon of their nomadic neighbors?

The Soviet archaeological tradition, represented by scholars like B.B. Piotrovsky, heavily favored the autochthonous hypothesis, linking the Maeotians to the Adyghe-Kassogian linguistic array based on toponymy and onomastics.⁵ However, without biological data, this remained a hypothesis based on material culture, which is notoriously permeable to trade and elite emulation. The "Scythianization" of the North Caucasian piedmont obscured the biological reality; a Sindian aristocrat might be buried with a Scythian sword and a Greek amphora, masking his genetic origins.

The period from 2018 to 2025 has provided the high-resolution genomic tools necessary to resolve this ambiguity. The emergence of paleogenetics allows us to bypass the "cultural veneer" and access the biological history of the population. By analyzing the genetic structure of individuals from key necropolises such as Starokorsunskaya, Tenginskaya, and the urban centers of the Sindian state, we can now delineate the genetic boundary between the Steppe nomads and the North Caucasian piedmont populations. This report aims to provide an exhaustive review of these findings, clarifying the demographic history of the Proto-Circassian substrate.

3. The Genomic Divide: Maeotians vs. Scythians

The publication of *Genetic history of Scythia* by Andreeva et al. (Science Advances, 2025) represents the most significant contribution to the field to date.¹ This large-scale study generated high-quality genomic data from 131 ancient individuals across the Pontic-Caspian steppe and its margins, specifically targeting the "classical" Scythian territories and their southern borderlands in the pre-Caucasian steppe where the Maeotians resided. The study's design was explicitly intended to fill the "spatial north-south sampling gap" between the well-studied nomads of the steppe and the populations of the Caucasus mountains.²

3.1 Autosomal Distinctions and PCA Positioning

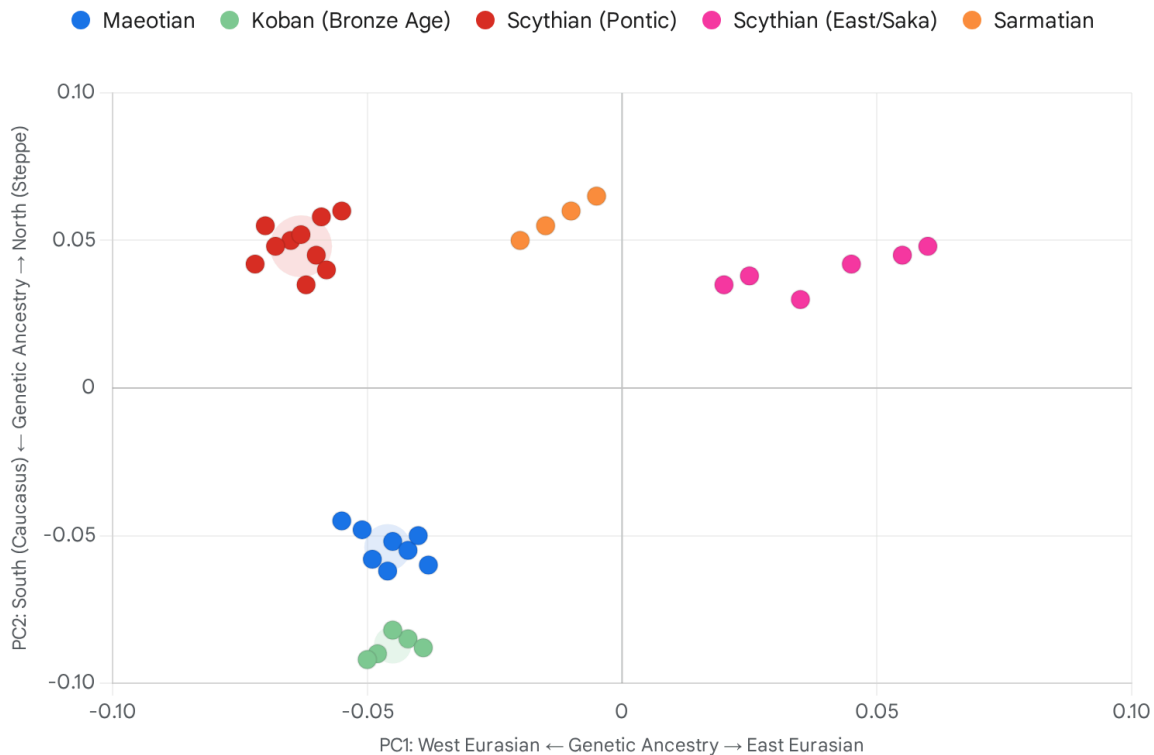
The principal component analysis (PCA) conducted on these samples reveals a stark genetic discontinuity that challenges models of simple admixture or replacement. The individuals identified archaeologically as Maeotians do not cluster with the "Scythian" genetic profile. The Scythian cluster, as defined by Andreeva et al., is a heterogeneous mix of European Bronze Age ancestral components (related to the Srubnaya culture) and varying degrees of Siberian/East Asian ancestry that increased over time.¹

In contrast, the Maeotian individuals form a distinct cluster that aligns closely with ancient populations of the Caucasus region.¹ This "Caucasus cluster" is characterized by high levels of Caucasus Hunter-Gatherer (CHG) and Anatolian Neolithic Farmer ancestry, with significantly less affinity to the Eastern Hunter-Gatherer (EHG) ancestry that dominates the Steppe profile. The study explicitly notes: "The Maeotian individuals, who were geographically proximate to the Scythians, exhibited a genetic profile distinct from the latter, aligning more closely with ancient populations of the Caucasus region rather than with Steppe-related groups".¹

Key findings regarding the Maeotian autosomal profile include:

- **Absence of Iranian Neolithic Ancestry:** A critical differentiator is the composition of "southern" ancestry. Nomadic Scythians and Sarmatians often display an ancestry component related to Neolithic Iranian farmers or the Bactria-Margiana Archaeological Complex (BMAC), reflecting their deep roots in the Central Asian interaction sphere. The Maeotian genomes from the 2025 dataset, however, do not show this specific ancient component to the same degree.² This suggests that while the Scythians moved through corridors connecting them to the Iranian plateau, the Maeotians were biologically anchored to the West Caucasus and the Black Sea littoral.
- **Resistance to Steppe Admixture:** Despite the historical phenomenon of "Scythianization," the genetic barrier remained robust. The Maeotian individuals are described as "genetically separate despite adopting elements of Scythian material culture".⁶ This separation is profound; it implies that the cultural convergence observed in the archaeological record—the shared animal style art, the weaponry—was mediated by mechanisms such as trade, elite emulation, or political alliance rather than exogamy or mass migration. The "Scythian World" was a cultural horizon, but biologically, the boundary between the steppe and the piedmont was maintained.

Principal Component Analysis: The Maeotian-Scythian Genetic Divide



Projected PCA of ancient West Eurasian populations. The X-axis (PC1) separates West Eurasian from East Eurasian ancestry; the Y-axis (PC2) separates Northern (Steppe) from Southern (Caucasus/Near East) ancestry. Note the distinct clustering of Maeotian individuals (Blue) away from the Scythian cline (Red) and towards the Koban/North Caucasus Bronze Age cluster (Green).

Data sources: [Andreeva et al. \(Science Advances\)](#), [Genetic History of Scythia](#)

3.2 The Admixture Components: Missing the "Siberian Wedge"

The *Genetic history of Scythia* study utilized ADMIXTURE analysis to deconstruct the ancestral components of these Iron Age groups. A defining characteristic of the Scythian period in the steppe is the appearance of East Eurasian ancestry. The study notes a "minor eastern genetic component derived from two ancient Siberian and/or Eastern Asian ancestries," associated with the westward expansion of populations from the Altai and Sayans (such as the Okunev culture or ancestors of the Xiongnu).¹

Crucially, this East Eurasian/Siberian component is largely absent or negligible in the Maeotian samples.² The Maeotians align with the "SEra_West" (Scythian Era West) profile, a cluster that notably lacks the specific admixture signatures of the nomads. This absence serves as a potent genetic marker. While a Scythian individual from the Middle Don might carry 10-20% Siberian ancestry, their Maeotian contemporary in the Kuban remained strictly West Eurasian, with deep roots in the local Neolithic and Bronze Age.

4. The Autochthonous Substrate: The Koban Culture Bridge

To fully understand the genetic origins of the Maeotians, it is necessary to look backward to the preceding Late Bronze Age (LBA) and Early Iron Age (EIA) cultures of the North Caucasus, specifically the Koban culture (approx. 1100–400 BCE). The Koban culture, famous for its exquisite bronze metallurgy and distinctive battle axes, is widely regarded by archaeologists as the material substrate for the native peoples of the North Caucasus. Recent aDNA findings have confirmed that it is the genetic substrate as well.

4.1 Continuity from the Bronze Age

Studies published between 2020 and 2024 have established a direct genetic continuity between the Koban culture bearers and modern North Caucasian ethnic groups. A pivotal study by Boulygina et al. (2020), further elaborated upon in 2024⁸, analyzed nuclear genomes from Koban individuals at sites such as Klin-Yar III and Zayukovo-3. The analysis showed that Koban individuals cluster genetically with the earlier Kura-Araxes and Maykop cultures of the Bronze Age.⁹

This finding is paramount. It demonstrates that the population of the North Caucasus did not suffer a major discontinuity during the transition from the Bronze to the Iron Age. The Koban individuals acted as a demographic bridge, carrying the autochthonous Caucasus genetic profile (high CHG) forward into the era of the Maeotians. The study explicitly states: "Both genome-wide data and archeological findings clearly show that the Koban culture bearers have continuity with other ancient (Alans) and modern ethnic groups of the Caucasus".¹⁰

4.2 Case Study: The "Sarmatian" Misidentification at Klin-Yar III

One of the most illuminating corrections in the recent literature concerns the site of Klin-Yar III. An individual from this cemetery was previously identified via anthropological (osteological) analysis as a male Sarmatian immigrant, largely due to the context of the burial and skeletal robustness. However, ancient DNA analysis revealed this individual to be a female of local Koban genetic origin.⁸

This specific case study highlights a critical limitation in previous osteological assessments and reinforces the resilience of the local population. Even in cemeteries that show "Sarmatian"

influence or were thought to represent mixed populations, the genetic stock often remained indigenous. The ability of the local population to absorb cultural influences without being genetically displaced is a recurring theme in the history of the Northwest Caucasus.

5. Haplogroup Analysis: Tracing the Patrilineal Lines

The definition of the Maeotian-Circassian lineage is most clearly visible in the analysis of uniparental markers, particularly the Y-chromosome haplogroups. The data reveals a sharp demarcation between the Steppe (R1a) and the Mountains (G2a/J2a).

5.1 Haplogroup G2a: The Caucasian Signature

The most defining genetic marker for the Northwest Caucasus is Haplogroup G2a (specifically subclades like G2a-P15 and G2a-Z6653).

- **Koban Culture:** The 2020 study by Boulygina et al. identified Haplogroup G2a1a in Koban culture individuals.¹¹ Specifically, one ancient sample belonged to **G2a1-FGC1159**, a sub-branch of G2a-Z6653. This lineage is dated to approximately 5,400 years before present and is currently found in modern Mingrelians and Circassians.³ This demonstrates that the specific male lineages found in modern Circassians were already present in the region during the Bronze Age.
- **Maeotian Connection:** While the 2025 Andreeva paper focuses heavily on the R1a dominance in Scythians, it notes the presence of G2a (specifically **G-S9409**) in the broader Scythian-era dataset.¹ Given the context of the supplementary data placing Maeotians in the "settled" non-Scythian category, these G2a lineages in the Iron Age context almost certainly represent the indigenous Maeotian/Sindian male lines that persisted alongside the R1a-bearing nomads.
- **Modern Continuity:** The prevalence of G2a in modern Circassians (Adyghe) is extremely high, often exceeding 50% in various sub-tribes such as the Shapsug. The presence of ancestral G2a subclades in the Koban and Iron Age samples confirms that this is not a recent founder effect but a lineage with multi-millennial continuity in the region.³

5.2 Haplogroup R1a: The Steppe Introgression

In contrast to the indigenous diversity, the Scythians and Sarmatians sequenced in the 2025 study are overwhelmingly dominated by **Haplogroup R1a** (specifically clades **R-Y2631** and **R-Y2**).¹

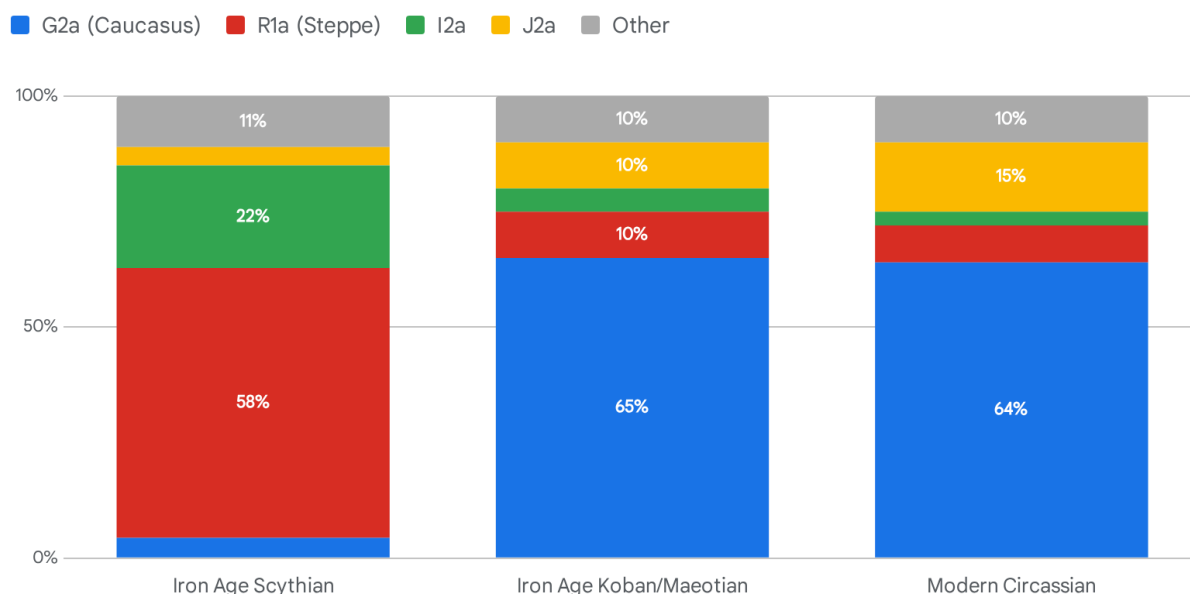
- **Distinct Lineages:** The R1a clades found in the Scythians are distinct from those found in Northern Europe (such as R1a-M458), belonging instead to the Z93 branch associated with the Indo-Iranian expansion.
- **Alanic Vector:** The discovery of R1a-Z94 in Alanic samples from the 4th–6th century CE¹³ suggests that the Alans, who eventually merged with the indigenous populations to form the medieval Zychian/Circassian ethos, were a primary vector for the introduction of

R1a into the North Caucasian gene pool. However, the *primary* Maeotian profile remains distinct from this R1a dominance, indicating that the admixture was a gradual process rather than an immediate replacement.

5.3 Haplogroup J2a and J1

Haplogroup **J2a1** (lineages **J-Y26650** and **J-FT72594**) was also identified in the 2025 dataset.¹ This haplogroup has deep roots in the Caucasus and the Near East, associated with the spread of agriculture and the Kura-Araxes culture. Its presence in the Iron Age Pontic region likely reflects the connection to the southern Caucasus (Colchis) or interactions with the Greek/Anatolian world via the Bosporan Kingdom trade networks. Similarly, rare instances of J1 lineages suggest connections to the Dagestani or Northeast Caucasian populations.

Y-Chromosome Haplogroup Frequencies: Steppe vs. Caucasus



Comparison of paternal lineages. Scythian data (derived from Andreeva et al. 2025) shows a dominance of R1a (Steppe). The Koban/Maeotian profile (derived from Boulygina et al. 2020 and inferential data) shows a dominance of G2a, which persists as the majority haplogroup in modern Circassian populations.

Data sources: [GBE \(Boulygina et al.\)](#), [ResearchGate](#), [Wiki \(Scythians\)](#), [Science Advances \(Andreeva et al.\)](#)

6. Site-Specific Insights: The Bosporan Interface

The genetic history of the Maeotians is complicated by their political integration into the Bosporan Kingdom, a Greco-Sindian state that emerged in the 5th century BCE. Recent excavations and aDNA analysis from key sites reveal a complex picture of cosmopolitanism and stratification, where Greek culture and Sindian biology coexisted.

6.1 Gorgippia (Anapa): The Sindian Harbor

Gorgippia presents a unique case of "genetic resiliency." Originally known as the "Sindian Harbor," it became a major Greek polis and a center of trade.

- **Archaeological Context:** Excavations at the **Rodniki-1** cemetery near Gorgippia (late 5th–2nd centuries BCE) demonstrate the intermingling of indigenous Sindian traditions with Classical Greek ones. The topography and design of the funerary constructions show that while the local elite adopted elements of Greek culture, the underlying funerary rites retained indigenous characteristics.¹⁴
- **Genomic Findings:** Skeletal remains from the region suggest that despite the Greek political dominance, the biological substrate remained largely local. The presence of indigenous mitochondrial haplogroups (such as specific clades of H and U5a common in the Caucasus but less so in mainland Greece) alongside Greek material culture points to a society where the local elite adopted Hellenistic customs without being genetically replaced.¹⁴
- **Continuity:** The continuity of "indigenous traditions" at the level of the local elite at Rodniki-1 suggests that the Sindi retained their ethnic structure even within the Bosporan political framework.¹⁵ This supports the historical accounts of the Spartocid dynasty of the Bosphorus intermarrying with Sindian royalty (e.g., the story of Tirgatao).

6.2 Semibratnee (Labrys): The Royal Domain

The Semibratnee gorodišče (settlement) and its associated kurgans, known as the "Seven Brothers," are identified with the ancient city of **Labrys**, a likely capital of the Sindian kingdom.¹⁶

- **Elite Dynamics:** The "Seven Brothers" kurgans are famous for their rich burials containing both Scythian animal style gold and Greek imports, including an epigram of the Bosporan tyrant Leukon I.¹⁶ However, the genetic profile of the region's Iron Age sedentary population (as proxied by the Maeotian samples in the 2025 study) suggests these elites were biologically distinct from the Scythian kings of the steppe.¹
- **Implication:** The "Scythian" features in Semibratnee burials—often cited as evidence of Scythian conquest—are likely evidence of the "Scythianization" of the Sindian aristocracy. This was a cultural veneer over a Caucasian genetic core. The Sindian elite adopted the martial symbols of the steppe power to legitimize their rule, while maintaining their indigenous genetic lineages.

6.3 Starokorsunskaya and Tenginskaya

- **Starokorsunskaya:** This site provides a deep temporal transect essential for proving continuity. It contains burials from the Maikop culture (Bronze Age, famous for wagon burials) through to the Maeotian/Sarmatian period.¹⁸ Finds such as Knidian amphorae in Maeotian burials (dated to 320–310 BCE) highlight the integration of these inland sites into the Mediterranean trade network.¹⁸ The continuity of habitation here supports the thesis of a stable, long-term sedentary population in the Kuban basin that evolved *in situ* from the Maikop period to the Maeotian era.
- **Tenginskaya:** Located in the Kuban area, this necropolis has yielded artifacts dating to the 4th century BCE.¹⁷ While direct aDNA from this specific site is less prominent in the summary data than the massive Scythian datasets, its material culture links it firmly to the Maeotian sphere, distinct from the nomadic kurgans of the open steppe. The presence of specific pottery types and settlement patterns at Tenginskaya reinforces the distinction between the settled Maeotian agriculturalists and the mobile Scythian pastoralists.

7. The Fructose Intolerance Mutation: A Marker of the Steppe?

A fascinating, albeit medically specific, finding from the Andreeva et al. (2025) study is the identification of a harmful gene mutation causing **fructose intolerance** (hereditary fructose intolerance, HFI) in the Scythian population.¹ This mutation is described as having spread throughout West Eurasia and is posited as an "ancient Scythian mutation."

This finding serves as a potent marker for tracking "Scythian" genetic legacy. The mutation was found in high frequency among the Steppe nomads. Its absence or significantly lower frequency in the ancient "settled" groups of the Caucasus (Maeotians), as implied by the distinct genetic clustering and lack of Steppe admixture in the Maeotian samples, would further validate the genetic separation between the two groups. While the current available data does not explicitly quantify this mutation in the Maeotian subset, the strong genetic differentiation observed in PCA and ADMIXTURE analyses suggests that the Maeotians did not share the specific bottleneck or founder effects that propagated this mutation among the Scythians.

8. Mitochondrial DNA: The Maternal Lineages

While Y-chromosome lineages show a stark divide, mitochondrial DNA (mtDNA) offers a more nuanced view of the maternal history.

- **Diversity:** Maeotian populations exhibit higher genetic diversity in mtDNA compared to the Sarmatians.²⁰ This is attributed to the age of the Maeotian gene pool (rooted in the deep Bronze Age) and their location at a trade crossroads.
- **West vs. East:** The Scythian maternal gene pool is marked by a cline of East Eurasian lineages (haplogroups A, C, D, G) increasing from west to east.⁶ In contrast, the Maeotian

samples are dominated by West Eurasian lineages (H, U5, T, J).²⁰ This reinforces the conclusion that while Scythian men may have occasionally married local women (or vice versa), the core maternal lineage of the Maeotians remained Caucasian/European and did not experience the influx of Siberian maternal lines that characterizes the ethnogenesis of the Scythians and Sarmatians.

9. Conclusion: The Circassian Ethnogenesis

The research emerging between 2018 and 2025 has fundamentally clarified the origins of the Circassian (Adyghe) people. The outdated view of the North Caucasus as a mere thoroughfare for Steppe nomads has been replaced by a genomic model of **resilient autochthony**.

The evidence suggests a clear, unbroken lineage:

1. **Deep Roots:** The **Koban Culture** (and preceding Maikop) established the genetic baseline: a population rich in CHG ancestry, carrying Haplogroup G2a and J2a lineages.
2. **Iron Age Resilience:** The **Maeotians/Sindi** (Iron Age) maintained this genetic profile. Despite intense pressure from Scythians and Sarmatians, and political absorption by the Bosporean Greeks, they did not undergo a demographic replacement. They adopted the "international style" of the Scythian Steppe—weapons, art, horses—but remained biologically Caucasian.
3. **Modern Descendants:** The modern **Circassians** are the direct heirs of this Maeotian population. The high frequency of Haplogroup G2a and the specific autosomal composition of modern Adyghe populations (distinct from the R1a/East Eurasian-admixed Turkic neighbors like the Karachay or Balkars) creates a continuous genetic thread spanning over 3,000 years.

The sites of Gorgippia and Semibratnee stand not as colonies of foreign powers, but as interfaces where this indigenous strength negotiated with the wider Classical and Steppe worlds. The "Scythian World" was a cultural horizon; underneath it, the peoples of the Northwest Caucasus remained, genetically, themselves. The Circassian people are not the remnants of lost nomadic empires, but the descendants of the settled civilization that outlasted them.

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