fondazione banfi

SANGUIS JOVIS
ALTA SCUOLA DEL SANGIOVESE

VI Edizione
SUMMER SCHOOL
SANGUIS JOVIS

SANGIOVESE PHYGITAL

L'impatto della tecnologia dalla vigna al Metaverso

OCRA- Officine Creative dell'Abitare
Montalcino, 10-14 luglio 2023

Dalla vite selvatica ai vitigni coltivati: per una antropologia del vino

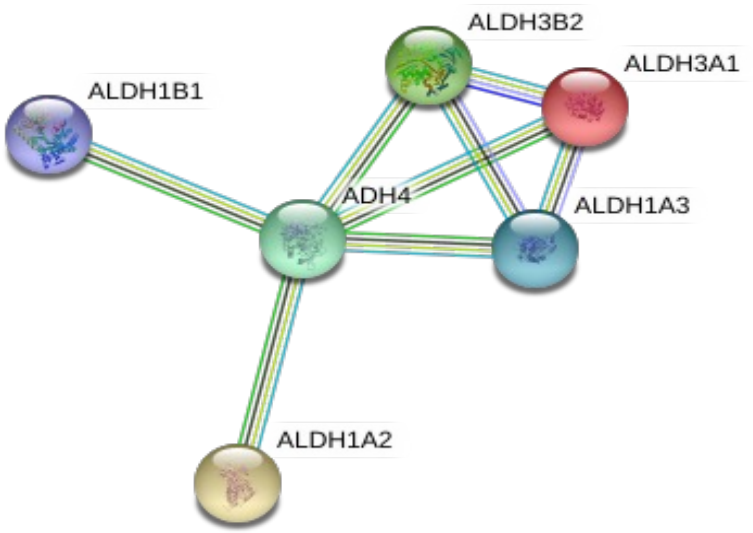
Osvaldo Failla - UNIMI

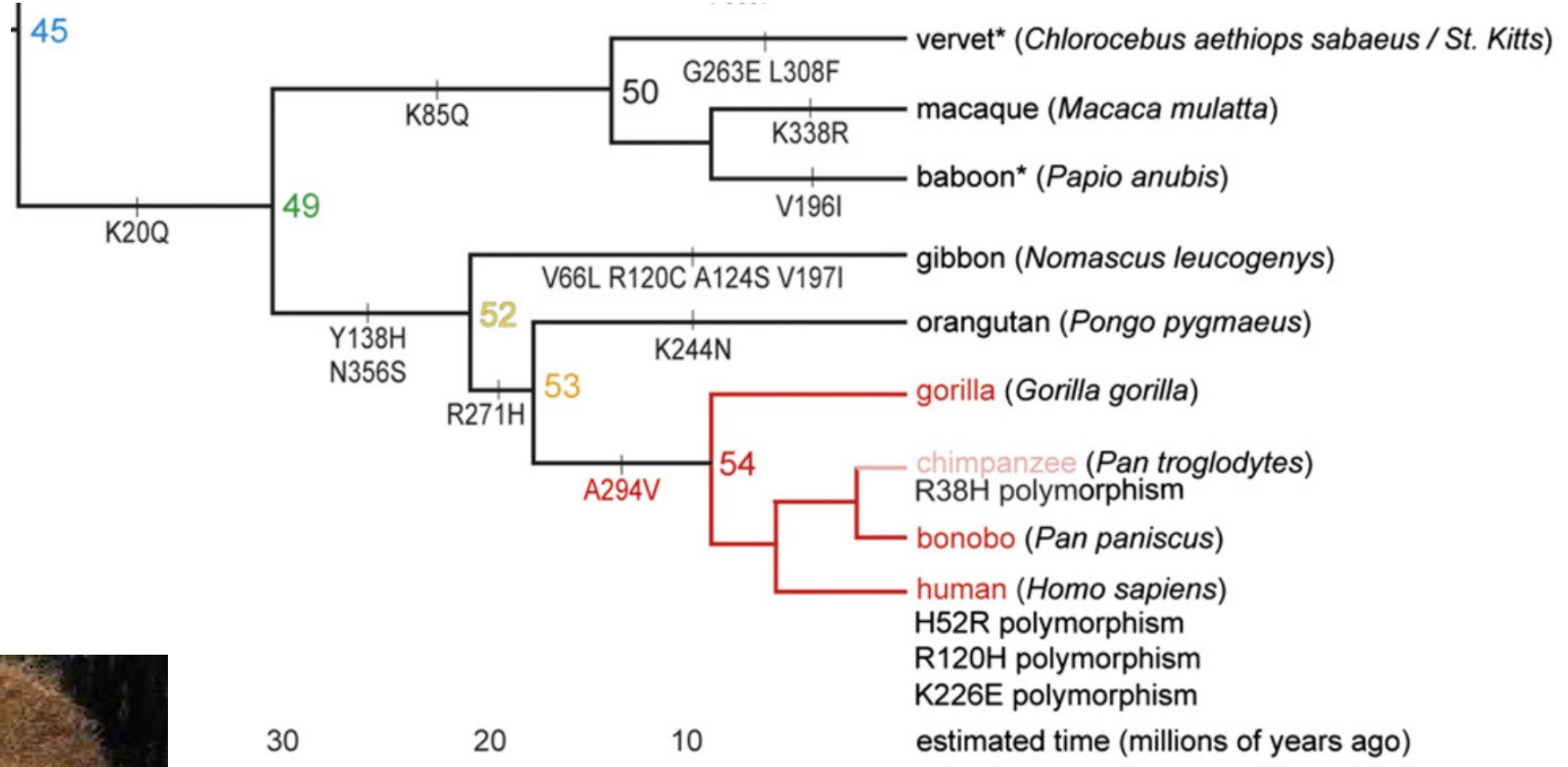
1. Grapes as food and row material for alcoholic beverages
2. Intensification of exploitation and cultivation of pre-domestic grapevines
3. The birth of the grape wine (and leaved bread) culture
4. The diffusion of the grape wine culture and the spreading of enology and grapevine cultivation
5. The domestication of grapevines (by fossil seed remains) and the spreading of domestic grapevines
6. The genomic data
7. The missing data

Pips of wild grapes have been found associated with the Paleolithic hut shelter at Terra Amata, Nice, southern France, dating back some 400,000 years; at the Grotta dell'Uzzo in Sicily, in the Franchthi Cave in Greece, at Tell Abu Hureyra in Syria, at Tell Aswad and at Jericho, all in levels dating between the 12th and 9th millennium bC

Reconstruction of the Terra Amata site, 400,000 years ago.
Credit: M. Wilson / City of Nice.

ADH4: a history of 13-21 million years ago



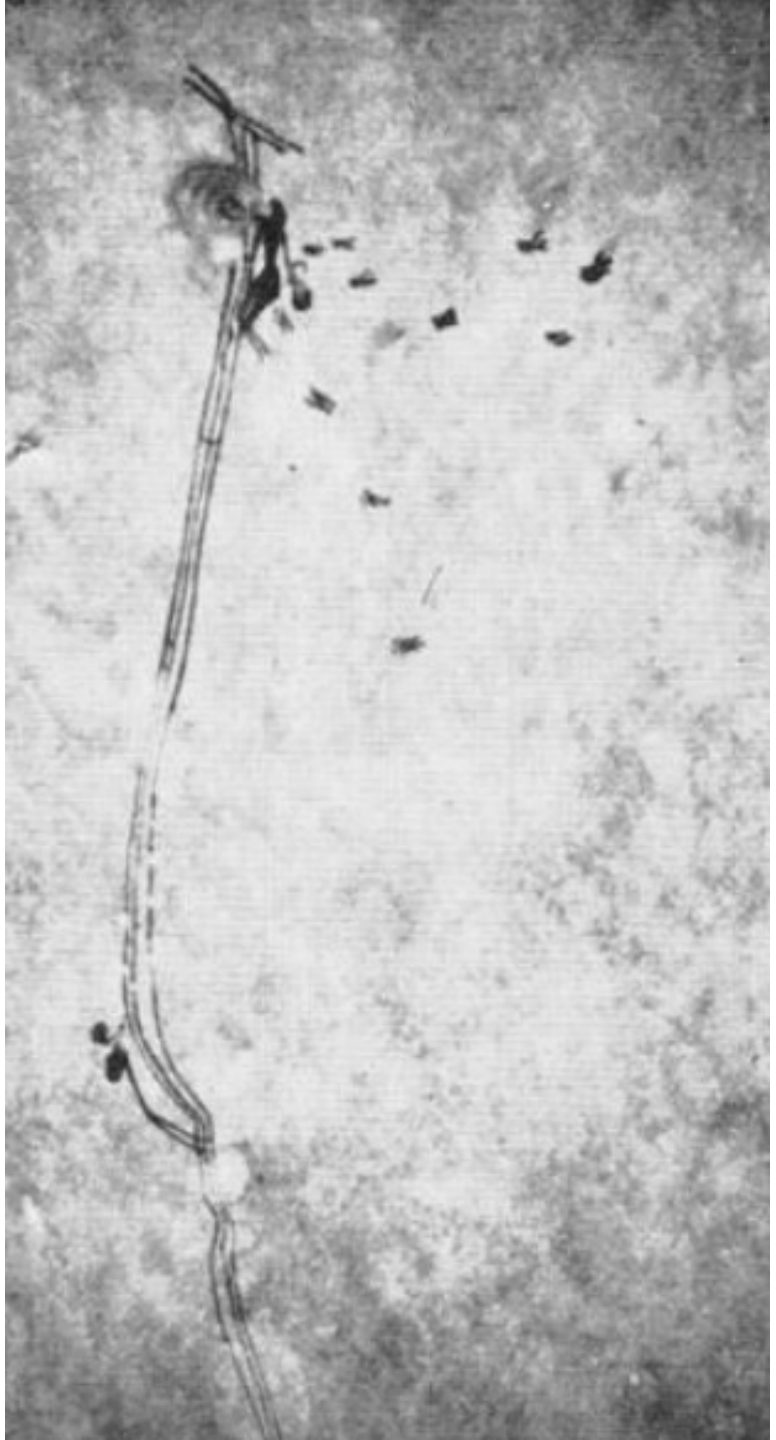


ADH4 is able to oxidize ethanol 40-fold better than the enzyme at node 53

Carrigan et al. 2015 PNAS vol. 112|no. 2|463

Laussel Venus, Upper Paleolithic (25.000 yrs BCE) Bas-Relief, Aquitaine Museum, Bordeaux, France.
Apic / Hulton Archive / Getty Images

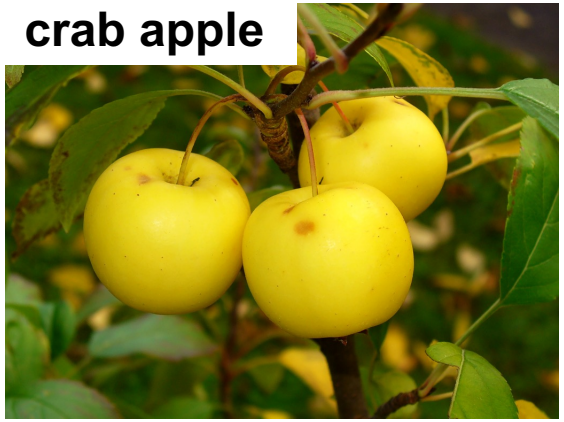
VADO ALL'ARANCIO (Massa Marittima – Tuscany, > 10000 yrs BCE



Cave drawing: honey harvesting scene.
Cueva de la Araña cave (Spain) (ca. 7000 BC).

Sorb tree

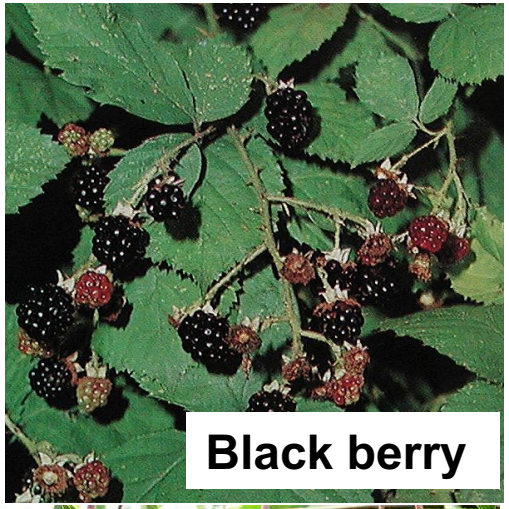
crab apple



Cornelian cherry

Raspberry

Wild grapes



Black berry

Elder berry

Honeyberry tree

Middle-Late Bronze Age (1650–1200 BC)

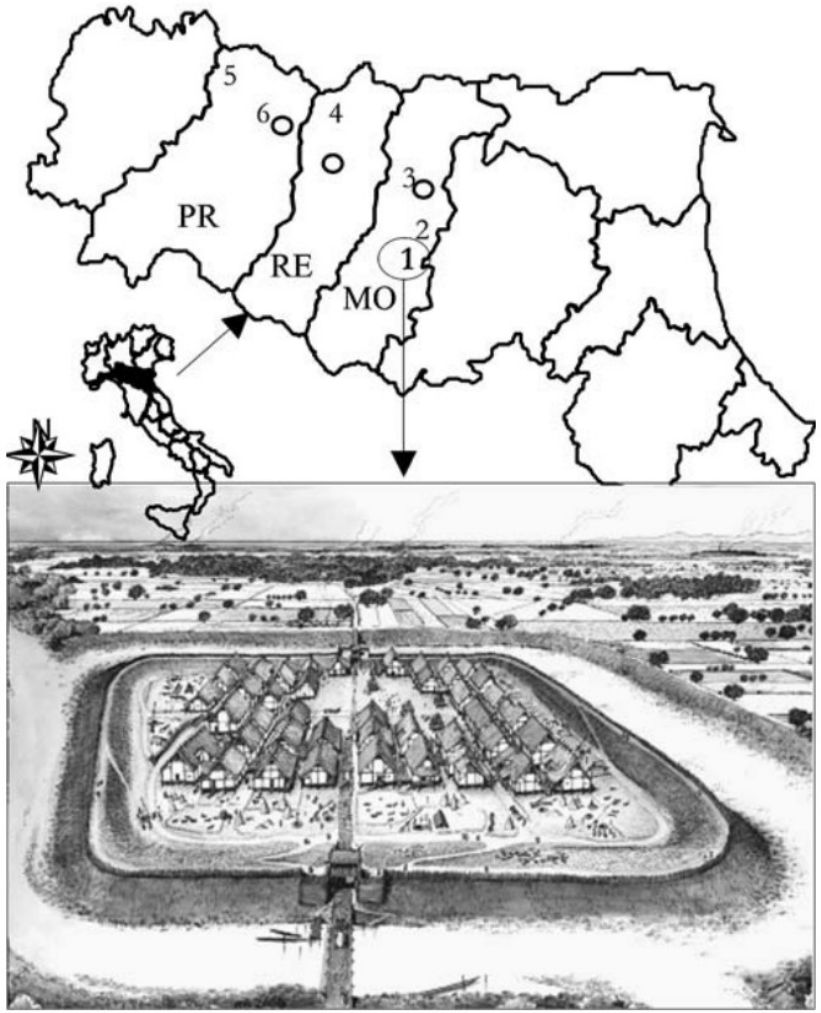


Fig. 1 Map showing the location of those Terramaras with archaeobotanical studies in three provinces of Emilia Romagna, North Italy. The reconstruction of the Terramara di Montale (site 1) was drawn by R. Merlo (modified from Cardarelli 2004); MO, Modena; (1) Montale, (2) S. Ambrogio, (3) Tabina di Magreta. RE, Reggio Emilia; (4), Terramara di S. Rosa. PR, Parma; (5) Castione Marchesi, (6) Parma

Cornelian cherry stones are always more abundant than grape pips, except in the two top phases IX and X, where grape pips dominate

Mercuri, A. M., Accorsi, C. A., Mazzanti, M. B., Bosi, G., Cardarelli, A., Labate, D., Marchesini, M., & Grandi, G. T. (2006). Economy and environment of Bronze Age settlements - Terramaras - On the Po Plain (Northern Italy): First results from the archaeobotanical research at the Terramara di Montale. *Vegetation History and Archaeobotany*, *16*(1), 43–60. https://doi.org/10.1007/s00334-006-0034-1

The first wine vat?

Medieval leather bags that have been found in archaeological excavations in Estonia
Hirsik, M. (2017) *Viisteist Eesti arheoloogilist nahast kotti*. Studia Vernacula, 8: 140–156.

THE REASON OF THE SUCCESS

A real unique enological fruit: rich of juice loaded in sugar and organic acids with a thin skin full of poliphenols and aroma precursors





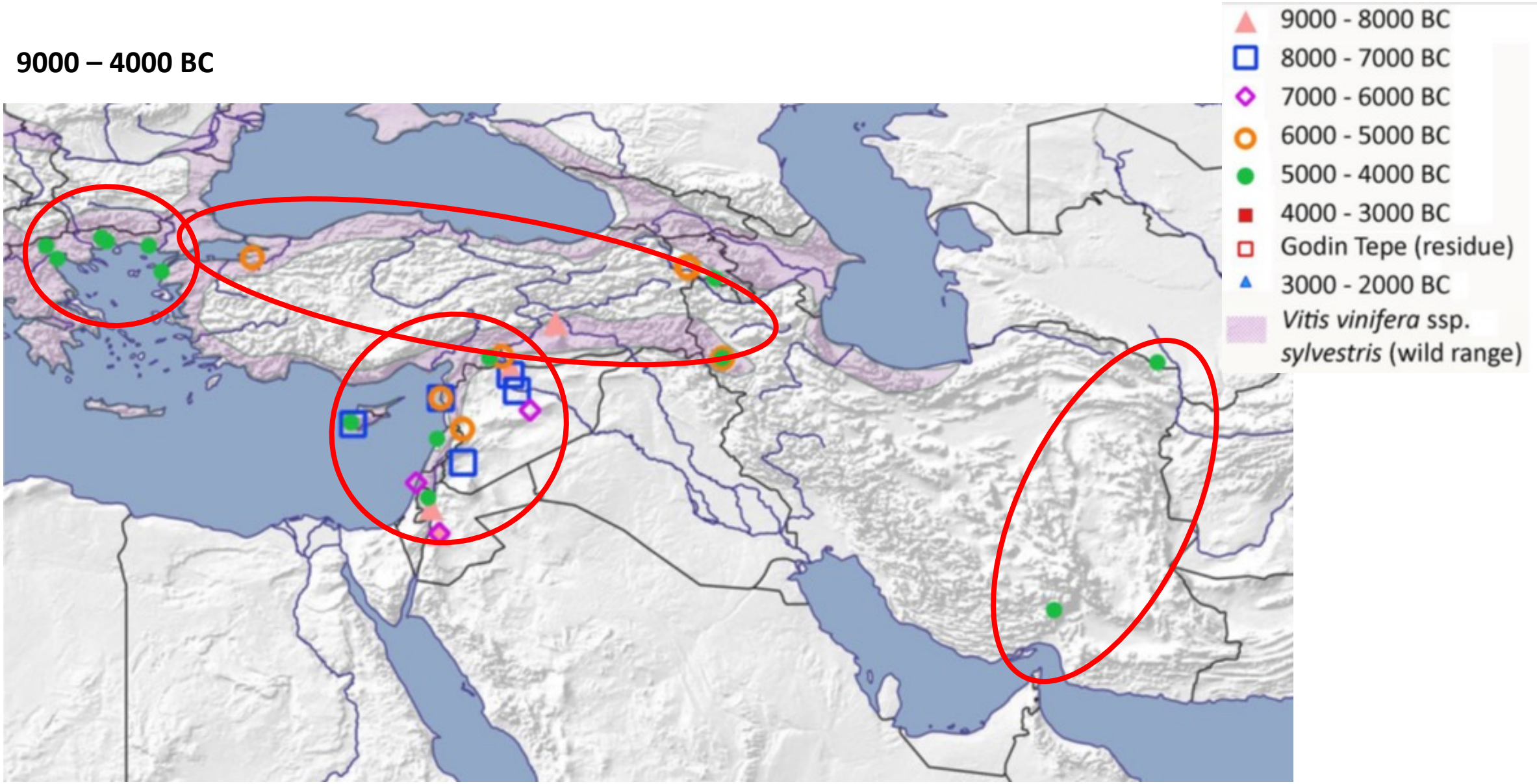

Maghradze et al. 2022 Ampelographic description of wild grapevines. In (D. Maghradze and O. Failla, eds.) , multidisciplinary comparative research to unravel the mystery of its domestication. Shota Rustaveli National Science Foundation of Georgia (SRNSFG). Tbilisi. 384 Pages, ISBN 978-9941-33-220-3

Table 2. Chemical parameters for the wines produced with wild grape, Cabernet Sauvignon, and Saperavi grapes. Data is expressed as average ± standard error of the three (2017, 2018, 2019) vintages investigated. Different letters mean significant differences (F-test). #: LS, level of significance: ns, non-significant; *, $p < 0.1$; **, $p < 0.05$.

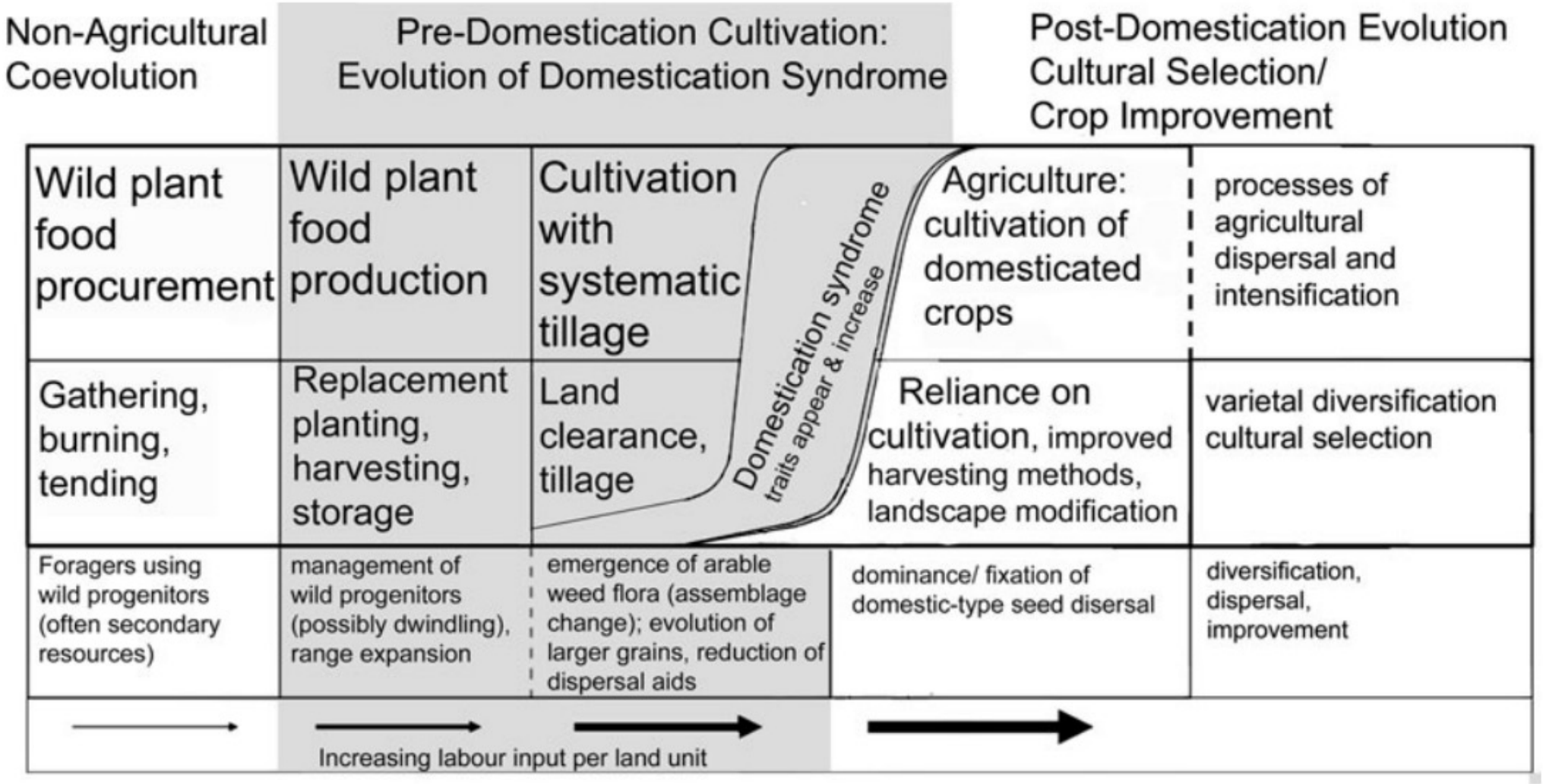
Wine	Wild Grape	Cabernet Sauvignon	Saperavi	LS #
Residual sugars (g/L)	3.0 ± 0.9 [a]	5.0 ± 4.5 [a]	1.9 ± 0.2 [a]	ns
Total acidity (g/L of tartaric acid)	7.1 ± 0.5 [a]	6.2 ± 0.2 [b]	7.2 ± 0.5 [a]	**
Volatile acidity (g/L of acetic acid)	0.5 ± 0.2 [a]	0.6 ± 0.1 [a]	0.6 ± 0.0 [a]	ns
pH	3.6 ± 0.0 [a]	3.3 ± 0.4 [a]	3.3 ± 0.2 [a]	ns
Ethanol (%, *v*/*v*)	14.2 ± 0.8 [a]	13.8 ± 1.0 [a]	13.7 ± 0.9 [a]	ns
Total phenol content (g/L of catechin)	3.1 ± 1.1 [a]	1.7 ± 0.4 [b]	1.7 ± 0.4 [b]	*
Total dry extract (g/L)	33.6 ± 3.7 [a]	31.4 ± 5.3 [a]	25.2 ± 1.9 [b]	*

Maghradze, D.; Kikilashvili, S.; Gotsiridze, O.; Maghradze, T.; Fracassetti, D.; Failla, O.; Rustioni, L. Comparison between the Grape Technological Characteristics of *Vitis vinifera* subsp. *sylvestris* and subsp. *sativa*. *Agronomy* **2021**, *11*, 472. https://doi.org/10.3390/agronomy11030472

9000 – 4000 BC

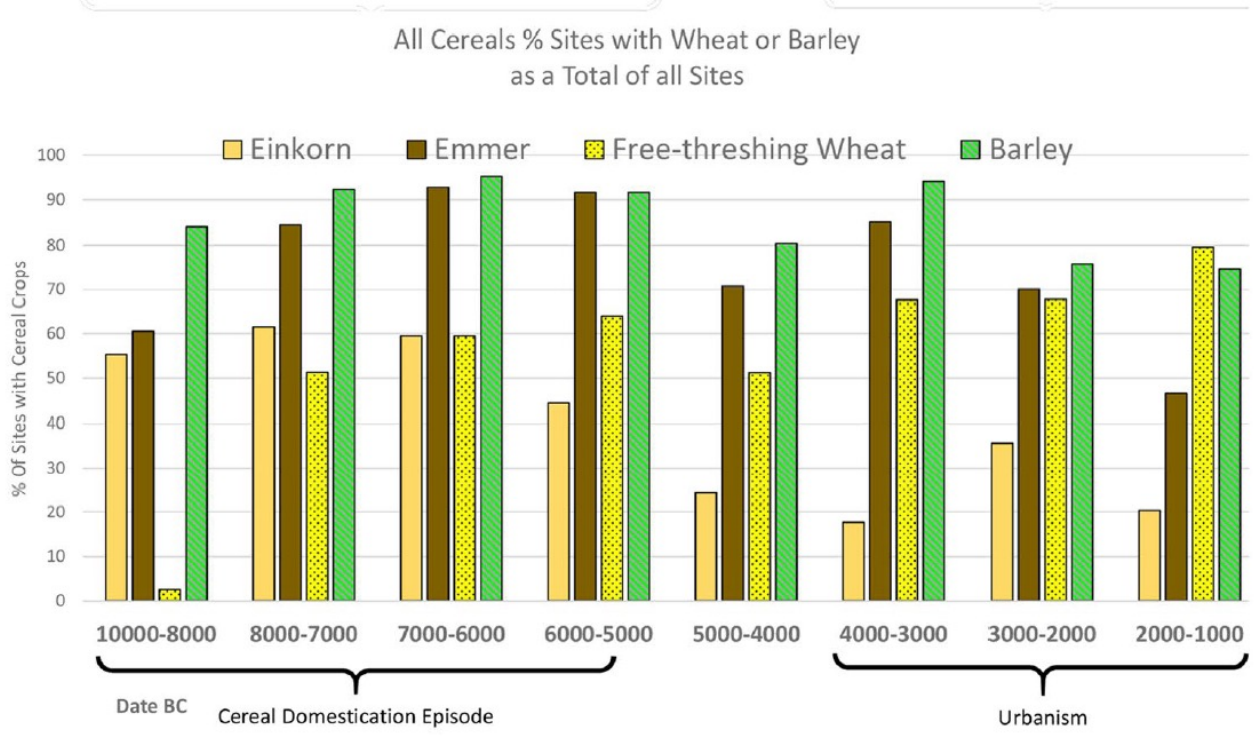


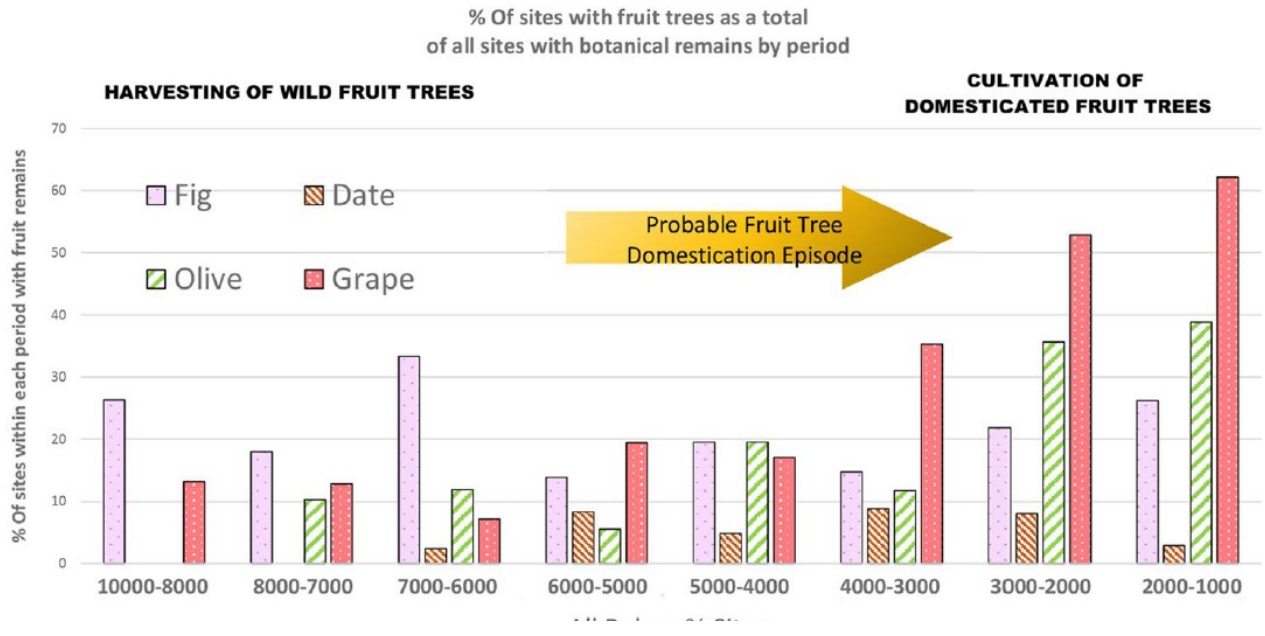
Fuller, D. Q., & Stevens, C. J. (2019). Between domestication and civilization: the role of agriculture and arboriculture in the emergence of the first urban societies. *Vegetation History and Archaeobotany*, *28*(3), 263–282.https://doi.org/10.1007/s00334-019-00727-4

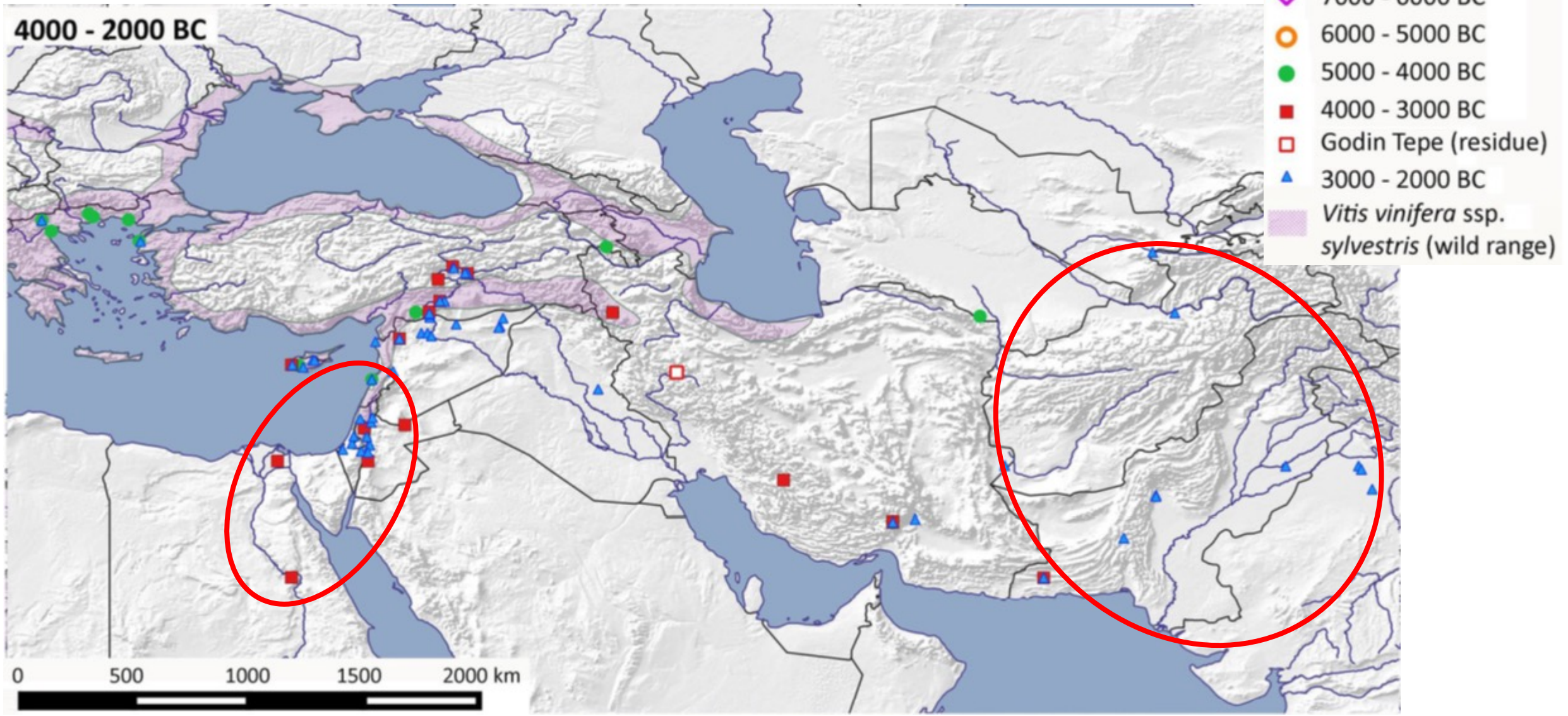


Agriculture: Definition and Overview, Fig. 1 An evolutionary model from foraging to agriculture, in which the transitions to cultivation, domestication, and agriculture are separated and potential archaeological indicators are suggested (Modified from Harris 1989 and Fuller 2007)

Harris D.R., Fuller D.Q. (2014) Agriculture: Definition and Overview . In (Moore, A. M. T. ed.) *Encyclopedia of Global Archaeology, pp. 104-113.* https://doi.org/10.1007/978-1-4419-0465-2

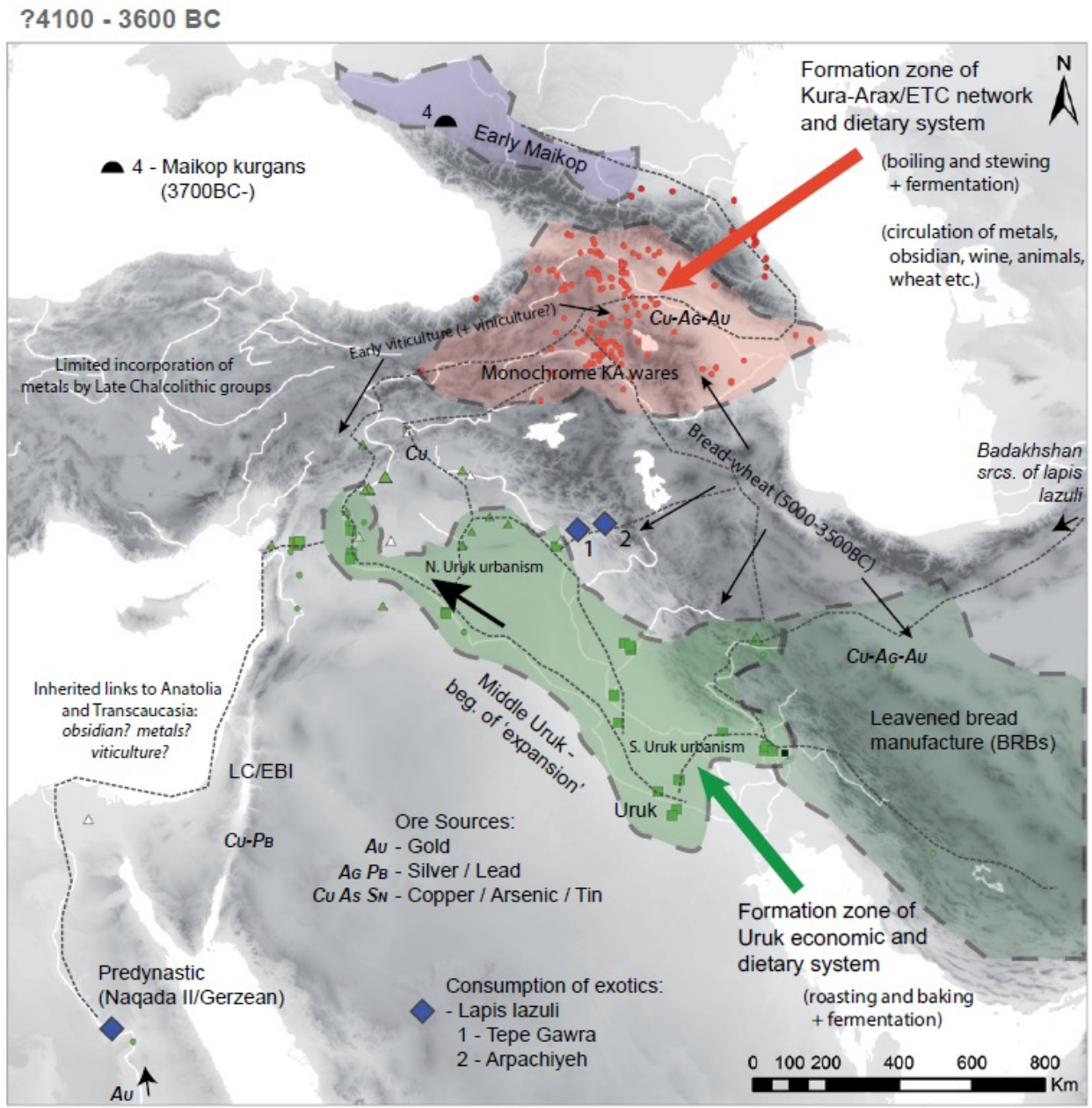

All Cereals % Sites with Wheat or Barley
as a Total of all Sites
Einkorn
Emmer
Free-threshing Wheat
Barley
% Of Sites with Cereal Crops
100
90
80
70
60
50
40
30
20
10
0
10000-8000
8000-7000
7000-6000
6000-5000
5000-4000
4000-3000
3000-2000
2000-1000
Date BC
Cereal Domestication Episode
Urbanism


% Of sites with fruit trees as a total
of all sites with botanical remains by period
HARVESTING OF WILD FRUIT TREES
CULTIVATION OF
DOMESTICATED FRUIT TREES
% Of sites within each period with fruit remains
70
60
50
40
30
20
10
0
Fig
Date
Olive
Grape
Probable Fruit Tree
Domestication Episode
10000-8000
8000-7000
7000-6000
6000-5000
5000-4000
4000-3000
3000-2000
2000-1000



Fuller, D. Q., & Stevens, C. J. (2019). Between domestication and civilization: the role of agriculture and arboriculture in the emergence of the first urban societies. *Vegetation History and Archaeobotany*, *28*(3), 263–282. https://doi.org/10.1007/s00334-019-00727-4

Early Transcaucasian Culture (4000 – 2000 BC)



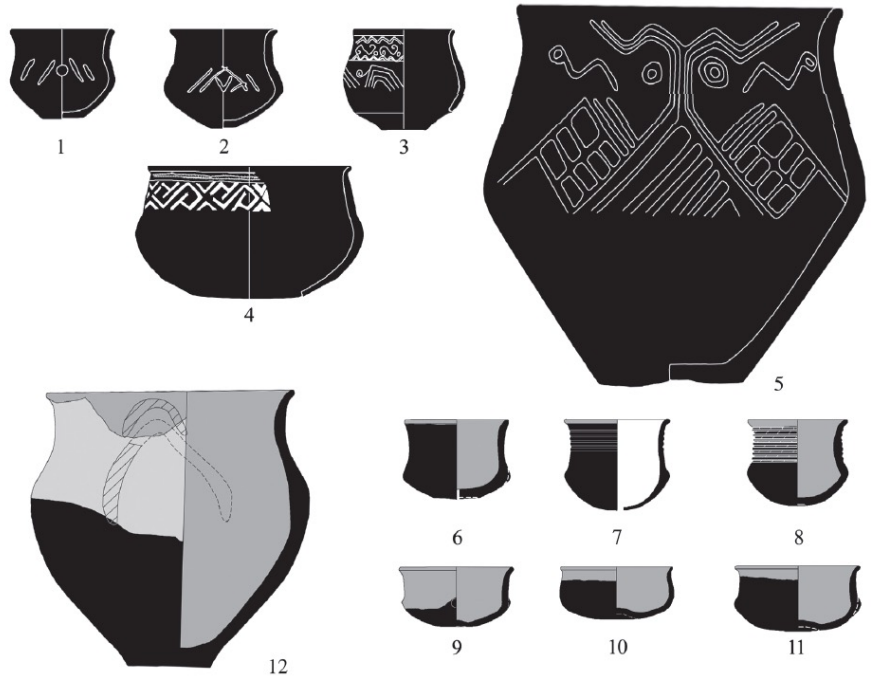


Fig. 7 – *ETC wine-assemblages? Cyma-recta vessels (after Batiuk 2013: 461, fig. 5).*

At least two such innovations seem to have come to a head in the early 4th millennium: the emergence of new culinary traditions and associated rituals based around fermented agricultural produce (beer, wine, bread) and an intensification of metal technology toward producing more complex objects (including vessels with which to imbibe such products).

Wilkinson Toby C. The Early Transcaucasian phenomenon in structural-systemic perspective: Cuisine, craft and economy. In: Paléorient, 2014, vol. 40, n°2. The Kura-Araxes culture from the Caucasus to Iran, Anatolia and the Levant: Between unity and diversity. pp. 203-229; doi : https://doi.org/10.3406/paleo.2014.5643

Macrobotanical remains: seeds, fragments of vine wood (fuel from the annual pruning), whole grapes (raisin), fragments of grape skins, flattened grape skins (also in within goat/sheep dung) and grape stem attachments (pedicels and rachis)

Microbotanical remains: pollen grains (wild vs. domestic; out the wild range)

Chemical residues: tartaric acid, anthocyanin malvidin, flavonols, flavanols

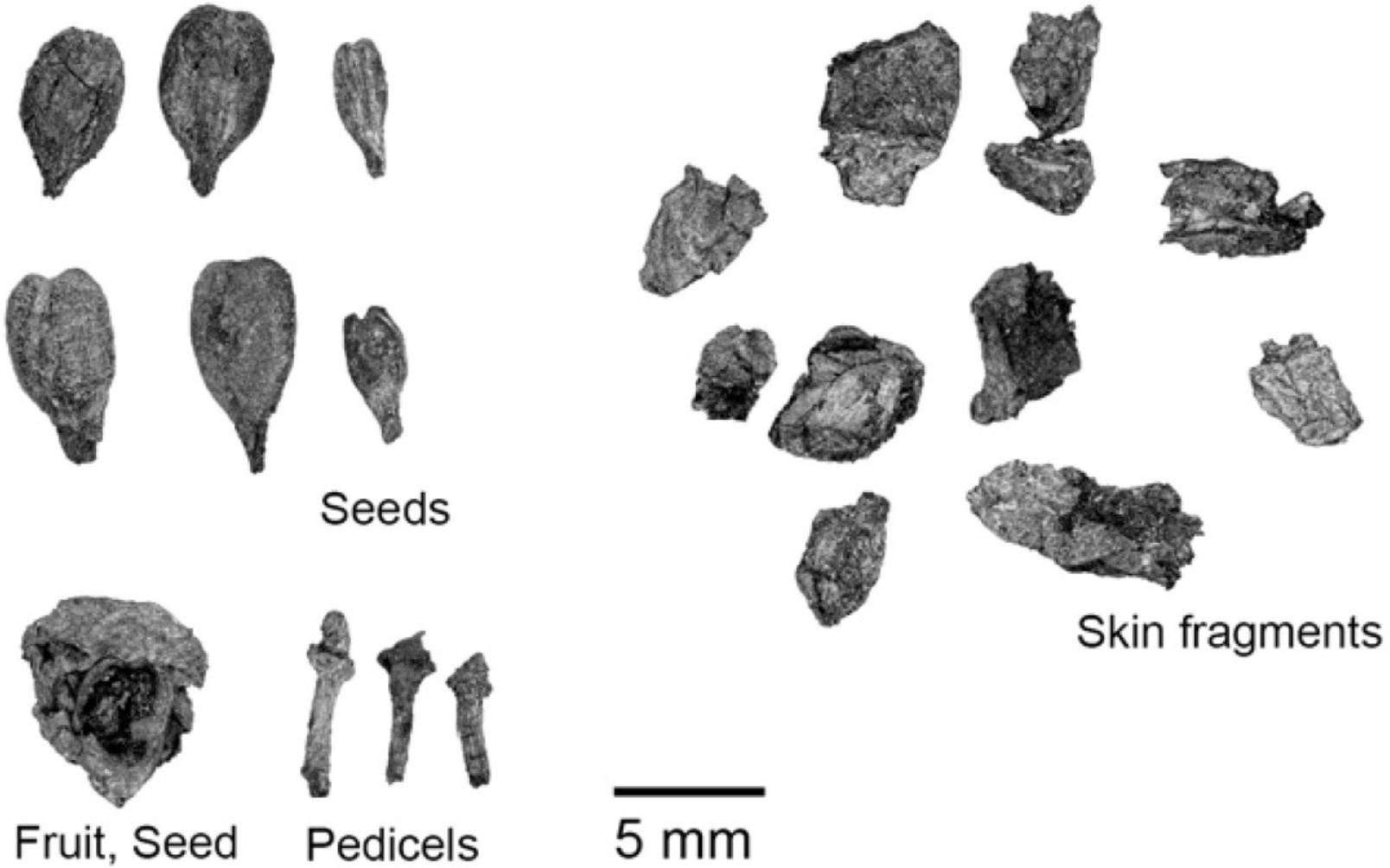
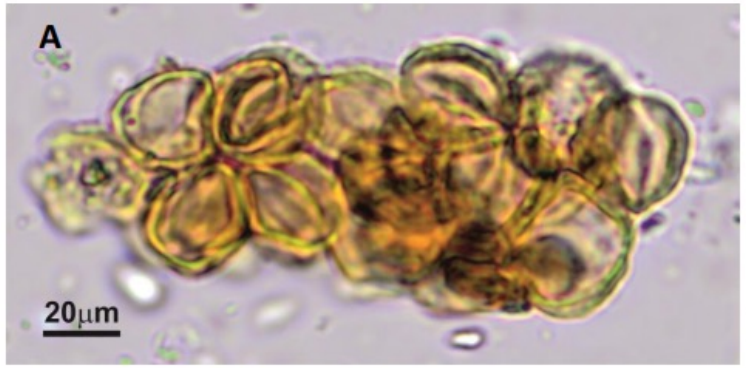


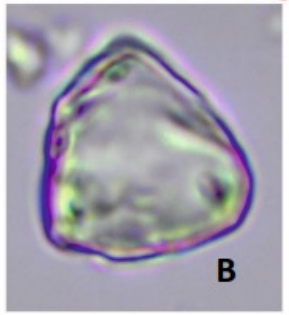
Fig. 2: Different categories of grape macrobotanical remains (Kurban Höyük, MRN 12806, Middle-Late Early Bronze Age).

White, C. E., & Miller, N. F. (2018). The Archaeobotany of Grape and Wine in Hittite Anatolia. *Die Welt Des Orients*, *48*(2), 209–224. https://doi.org/10.13109/wdor.2018.48.2.209

Fig. S7

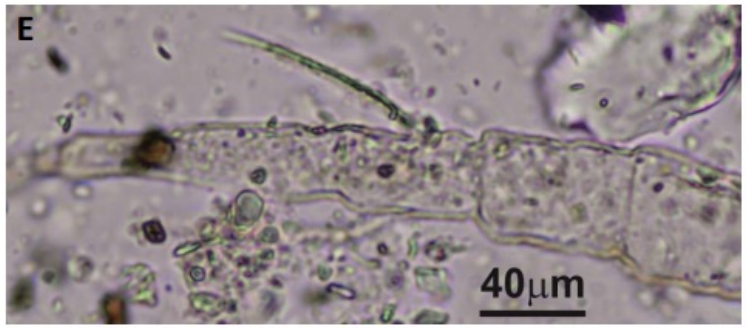
Grapevine pollen

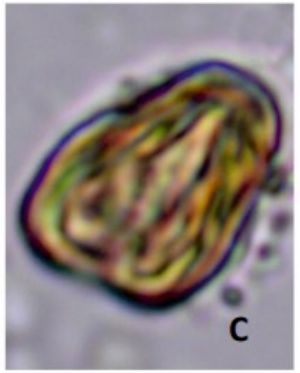




Grape starch

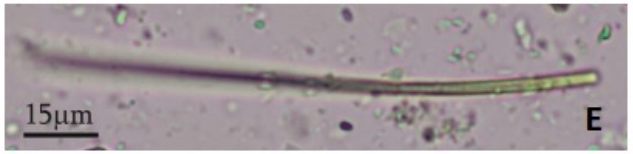
10μm

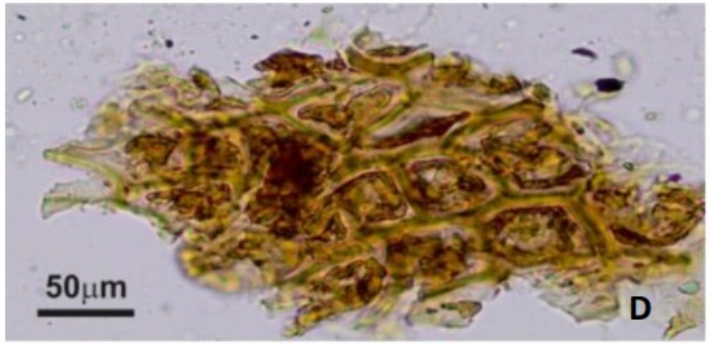




Grapevine pollen

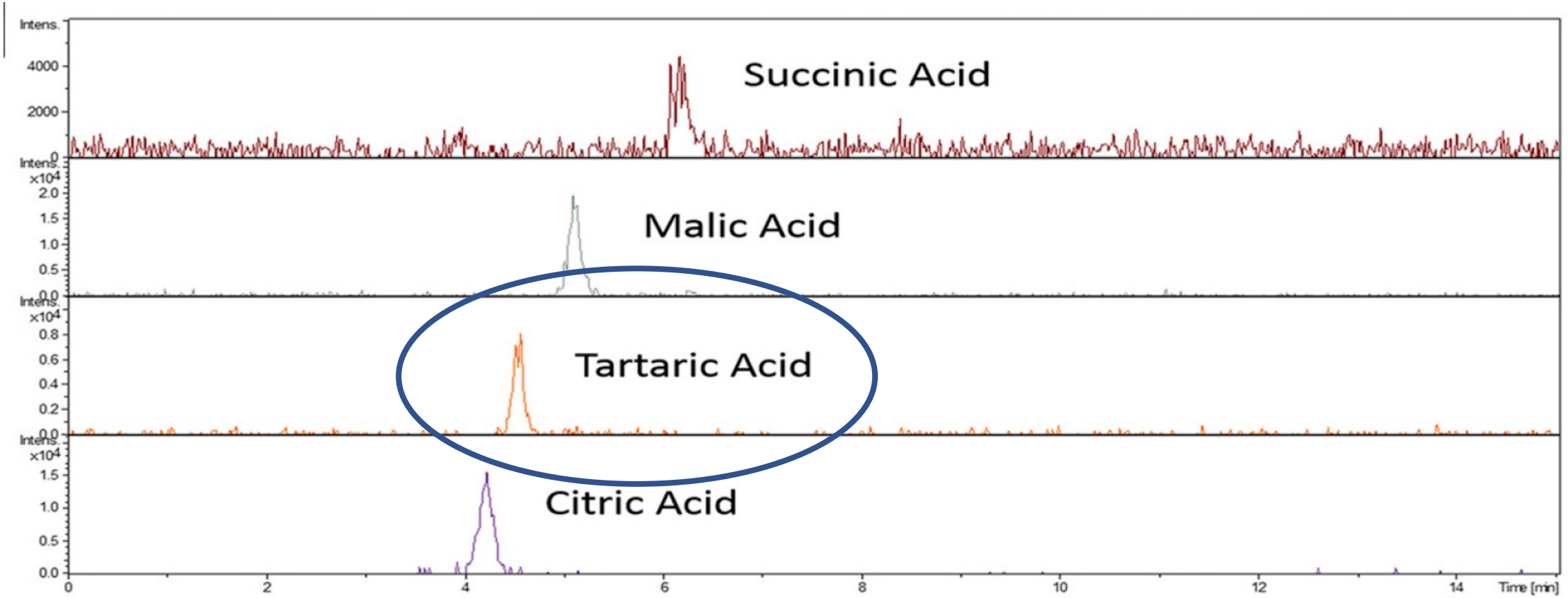
Fruit fly
Drosophila melanogaster



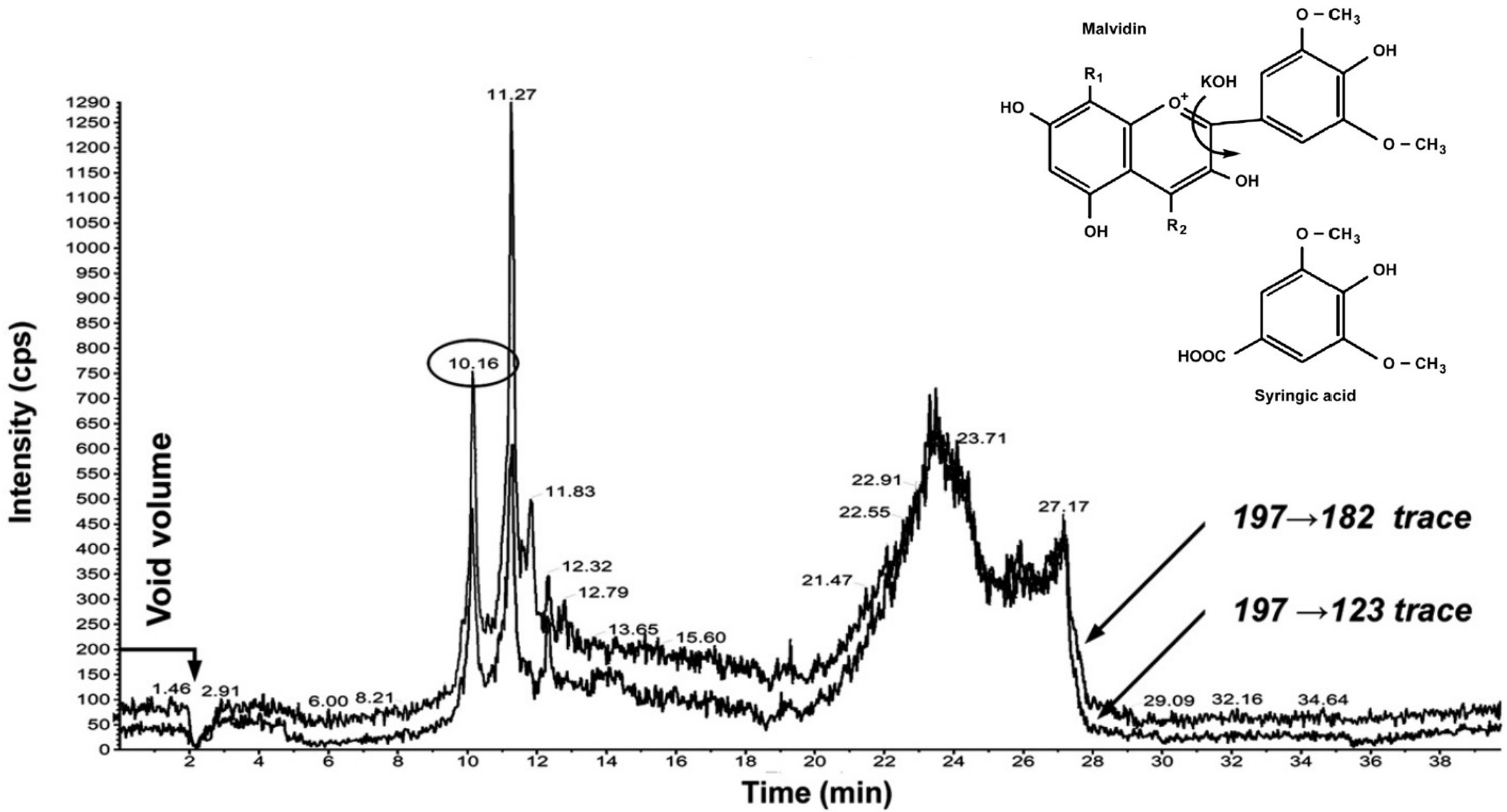


Grapevine epidermis

MCGOVERN, P., JALABADZE, M., BATIUK, S., CALLAHAN, M. P., SMITH, K. E., HALL, G. R., KVAVADZE, E., MAGHRADZE, D., RUSISHVILI, N., BOUBY, L., FAILLA, O., COLA, G., MARIANI, L., BOARETTO, E., BACILIERI, R., THIS, P., WALES, N., LORDKIPANIDZE, D. (2017). Early Neolithic wine of Georgia in the South Caucasus. Proceedings of the National Academy of Sciences, 201714728. doi:10.1073/pnas.1714728114



MCGOVERN, P., JALABADZE, M., BATIUK, S., CALLAHAN, M. P., SMITH, K. E., HALL, G. R., KVAVADZE, E., MAGHRADZE, D., RUSISHVILI, N., BOUBY, L., FAILLA, O., COLA, G., MARIANI, L., BOARETTO, E., BACILIERI, R., THIS, P., WALES, N., LORDKIPANIDZE, D. (2017). Early Neolithic wine of Georgia in the South Caucasus. Proceedings of the National Academy of Sciences, 201714728. doi:10.1073/pnas.1714728114



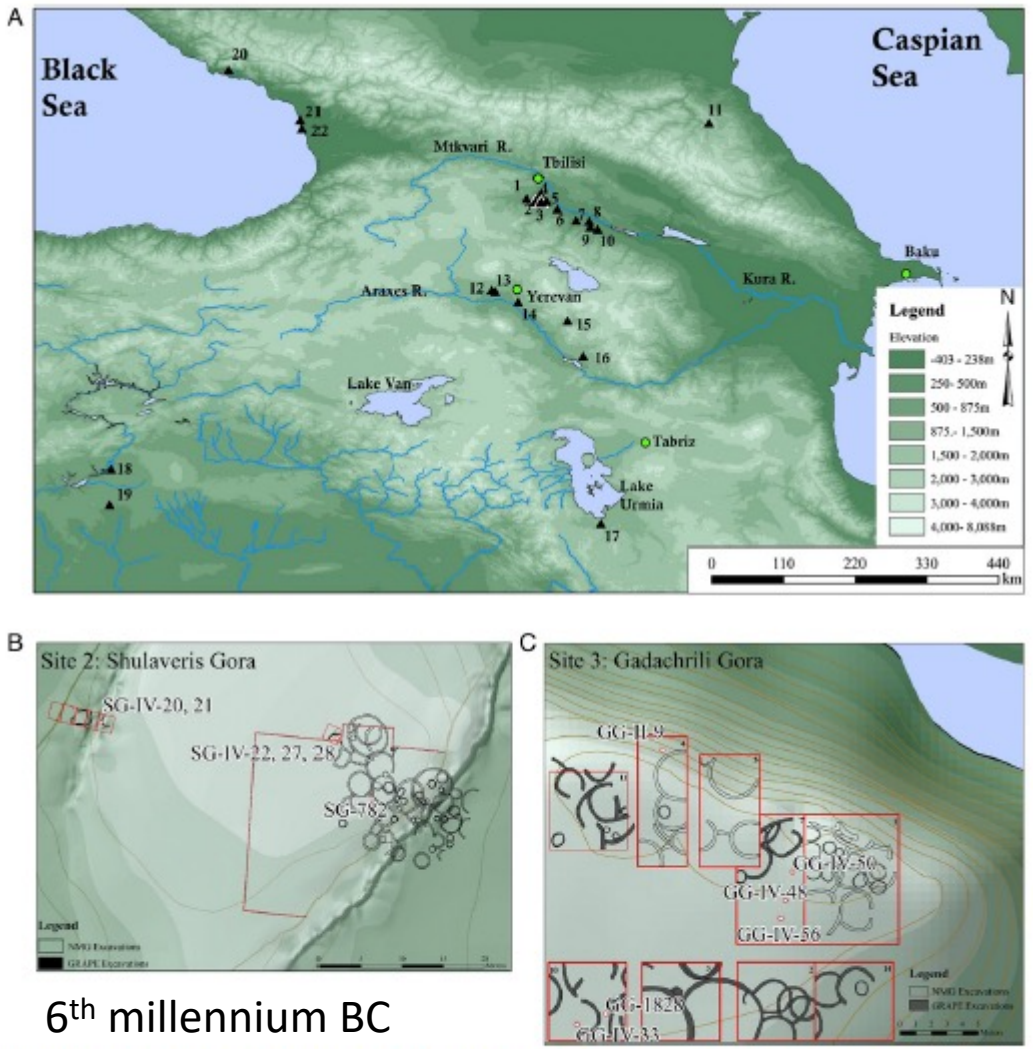
Barnard, H., Dooley, A. N., Areshian, G., Gasparyan, B., & Faull, K. F. (2011). Chemical evidence for wine production around 4000 BCE in the Late Chalcolithic Near Eastern highlands. *Journal of Archaeological Science*, *38*(5), 977–984. https://doi.org/10.1016/j.jas.2010.11.012

Contextual information:
Primary winemaking installations and grapes availability

Jars and vessels (fragments)

Press platform, stone basin

Past land suitability for (wild) grape growing and viticulture



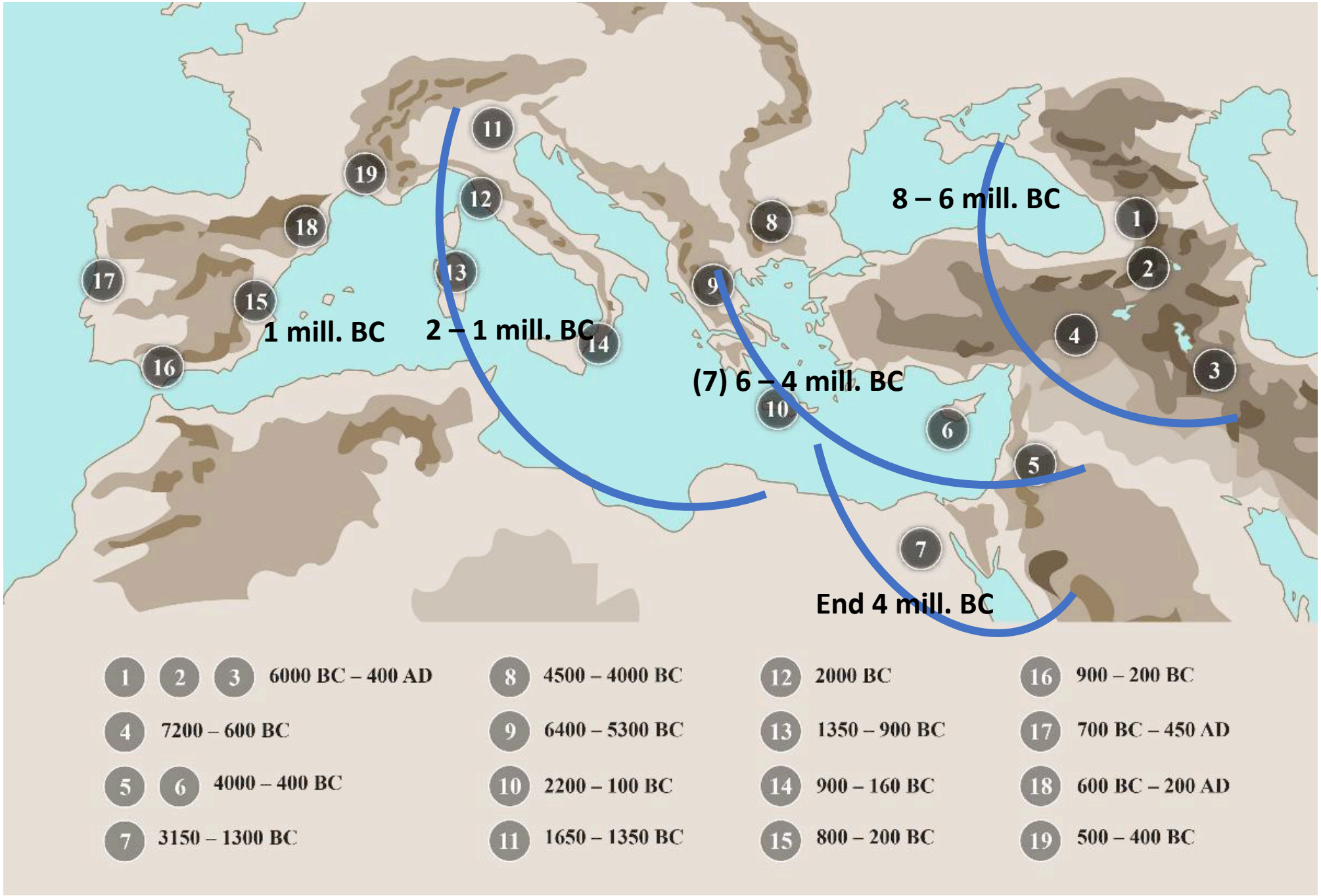
6th millennium BC

Fig. 1. Map of Shulaveri-Shomutepe Culture sites and other sites mentioned in the text (A) and the early Neolithic settlements of Shulaveris Gora (B) and Gadachrili Gora (C) showing the locations of the analyzed jar sherd samples that were positive for tartaric acid/tartrate. Site names: Arukhlo (1), Shulaveris Gora (2), Gadachrili Gora (3), Dangreuli Gora (4), Imeris Gora (5), Khramis Didi-Gora (6), Shomutepe (7), Haci Elamxali Tepe (8), Göytepe (9), Mentesh Tepe (10), Chokh (11), Aratashen (12), Aknashen (13), Masis Blur (14), Areni-1 (15), Kül Tepe (16), Hajji Firuz Tepe (17), Nevali Çori (18), Göbekli Tepe (19), Gudau River (20), Pichori (21), and Anaklia (22). GRAPE, Gadachrili Gora Regional Archaeological Project Expedition; NMG, National Museum of Georgia; R, river. Red lines indicate excavated areas and squares.

Fig. 2. (A) Representative early Neolithic jar from Khramis Didi-Gora (field no. XXI-60, building no. 63; depth, −5.45 to −6.25 m). (B) Jar base SG-16a, interior and cross-section. (C) Jar base SG-782, exterior. Note the textile impression on the base. (D) Jar base GG-IV-50, interior. (Photographs by Mindia Jalabadze and courtesy of the National Museum of Georgia.)

McGovern et al. - 2017 - Early Neolithic wine of Georgia in the South Caucasus - Proceedings of the National Academy of Sciences

An apparent wine press (in front of sign) and fermentation vat (right) emerge during a dig in Armenia
PHOTOGRAPH COURTESY GREGORY ARESHIAN



Modified by Harutyunyan, M.; Malfeito-Ferreira, M. The Rise of Wine among Ancient Civilizations across the Mediterranean Basin. Heritage **2022**, 5, 788–812. https://doi.org/10.3390/heritage5020043

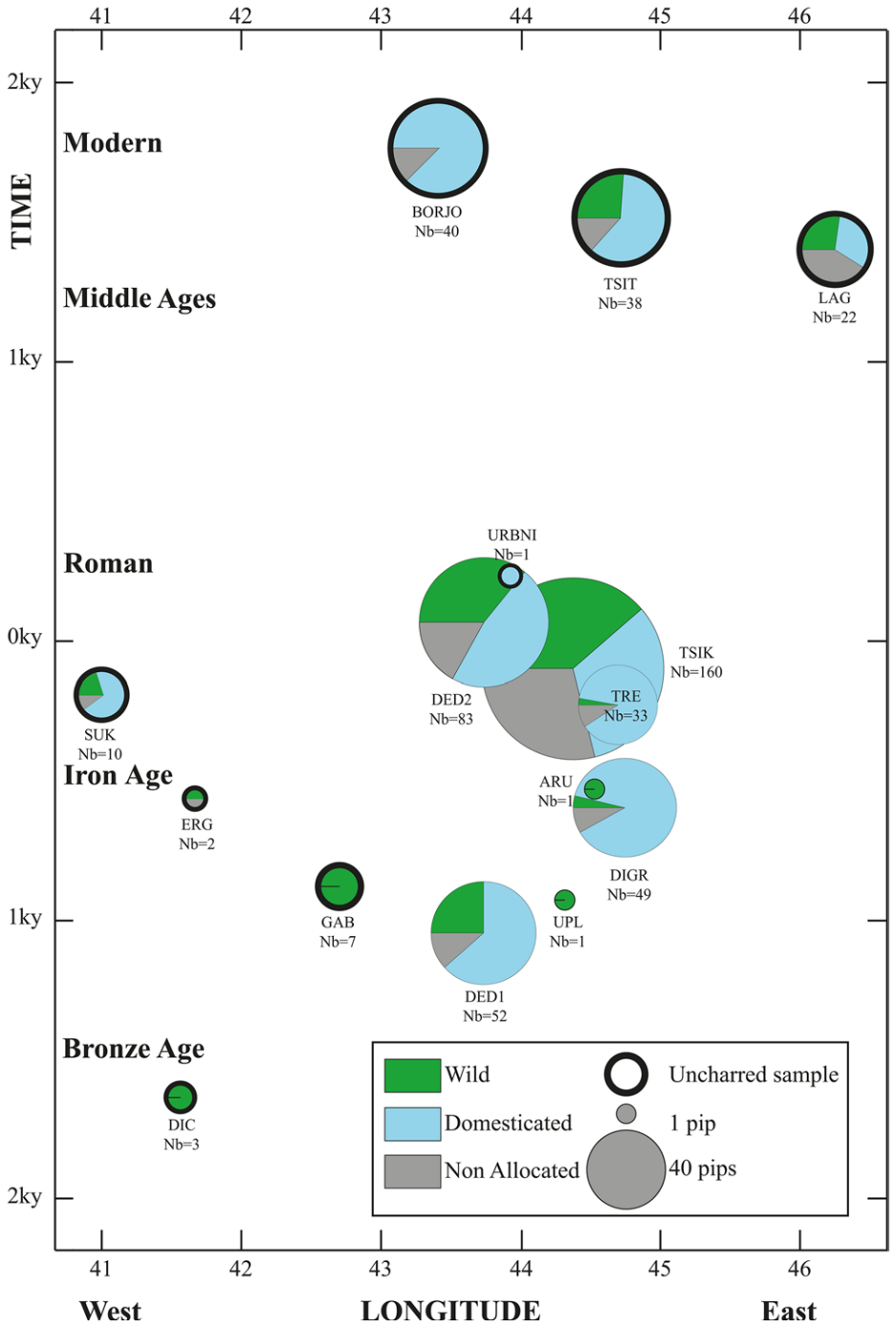
WILD DOMESTIC

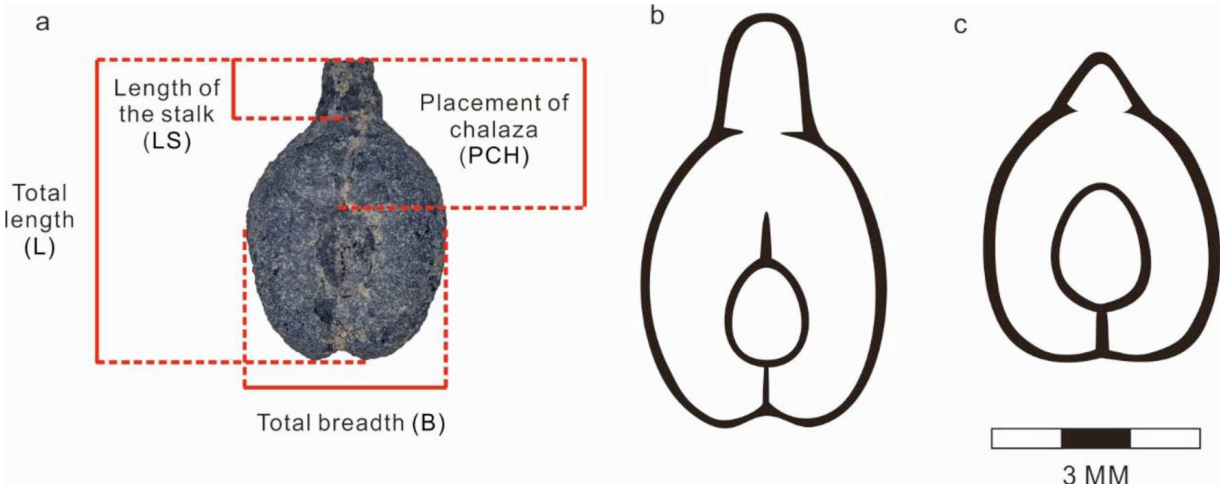
Evidence for the start of systematic cultivation remains elusive.

[…]

Morphological change in terms of grape pip lengthening would certainly be indicative but may only evolve later in the domestication process, and is yet to be systematically studied for West Asia …

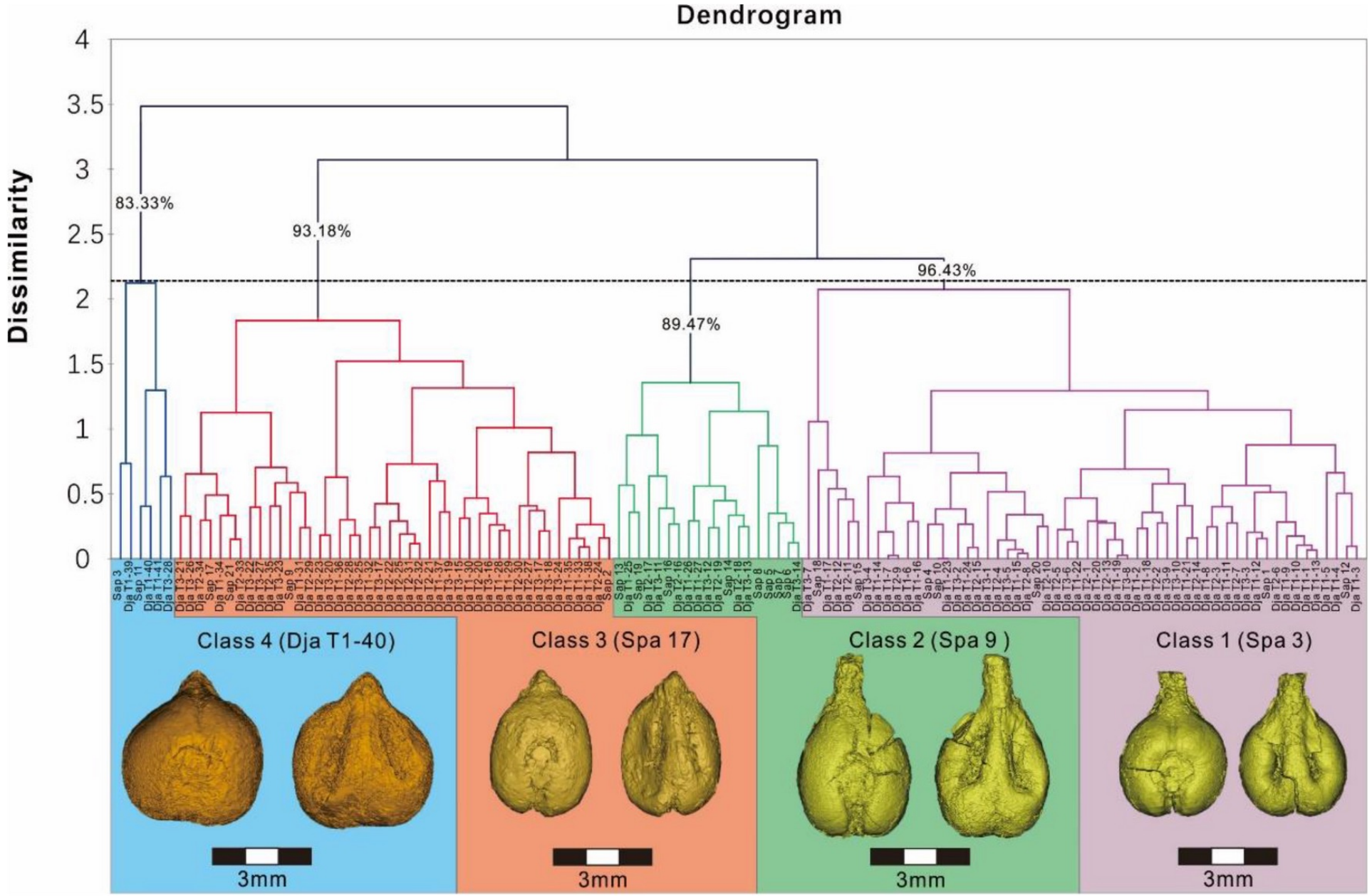
Fuller, D. Q., & Stevens, C. J. (2019). Between domestication and civilization: the role of agriculture and arboriculture in the emergence of the first urban societies. *Vegetation History and Archaeobotany*, *28*(3), 263–282. https://doi.org/10.1007/s00334-019-00727-4





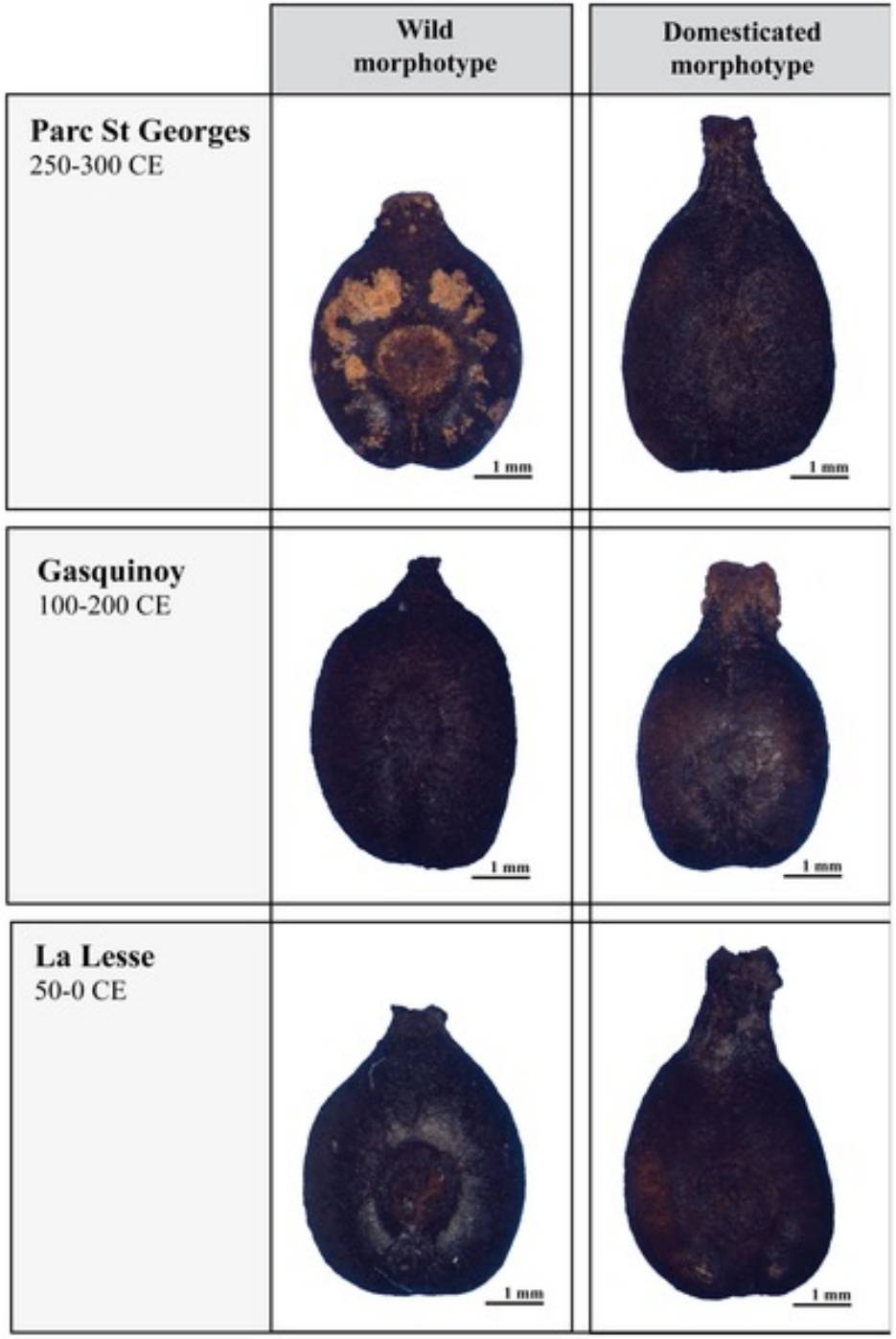
Proportions of pips allocated by the LDA to the domesticated and wild morphotypes in each sample. The samples are arranged according to their chronology and location (longitude)

Bouby, L. *et al.* Tracking the history of grapevine cultivation in Georgia by combining geometric morphometrics and ancient DNA. *Veg. Hist. Archaeobot.*, 1–14 (2020).

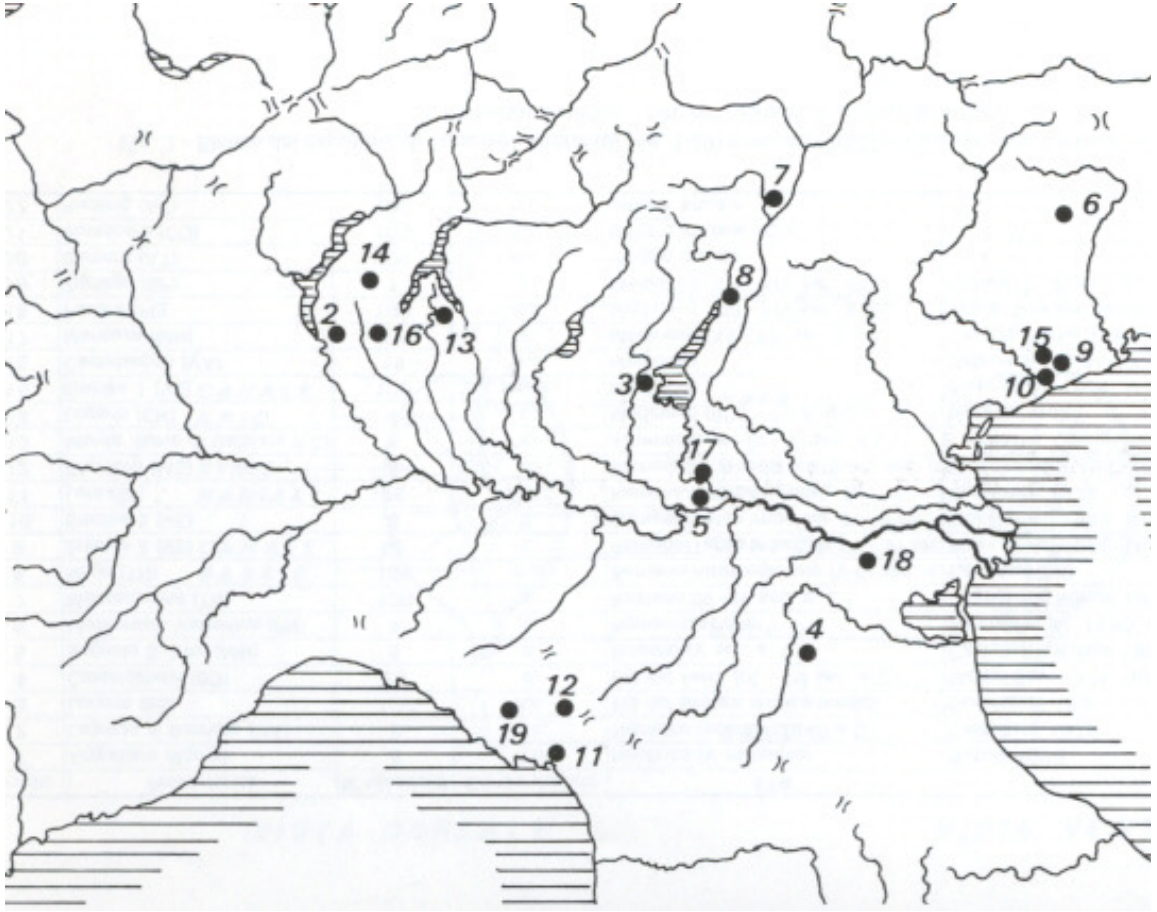


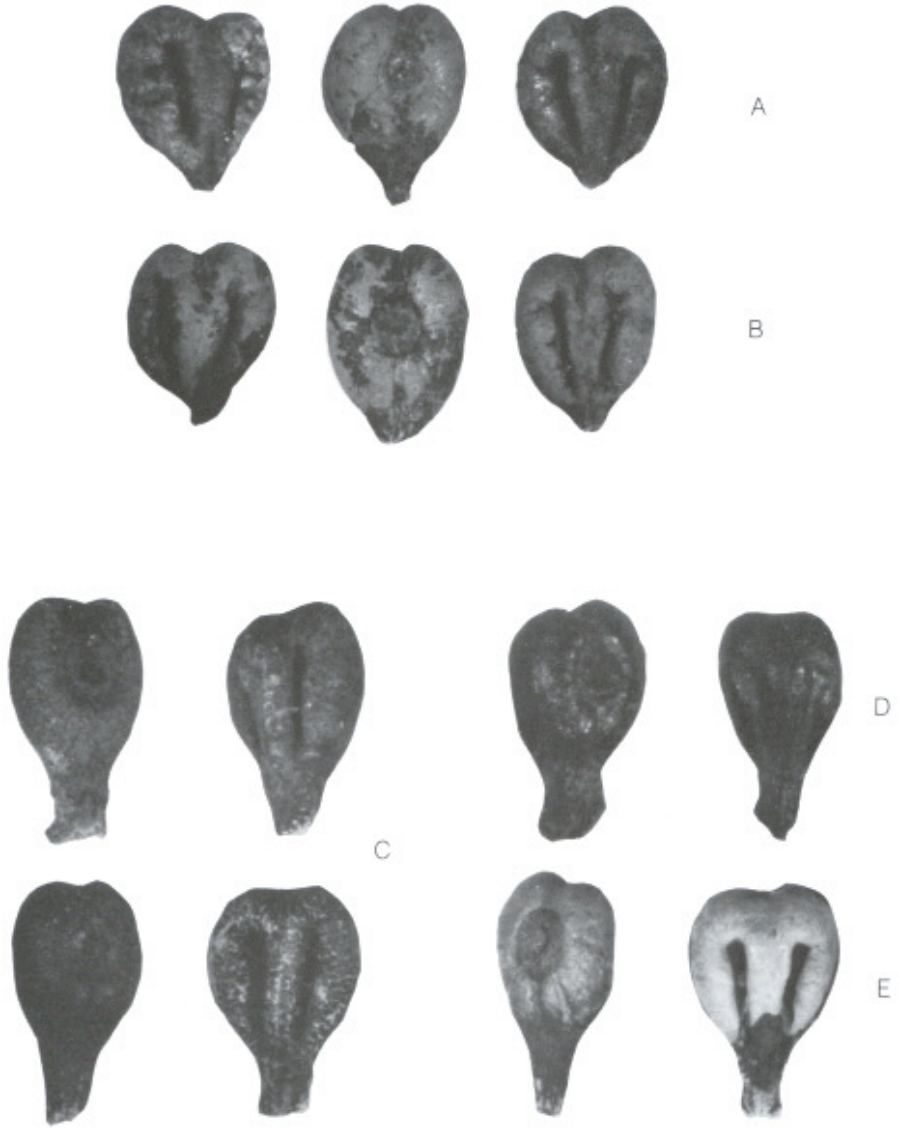
Chen, G., Zhou, X., Khasannov, M., Spengler, R. N., Ma, J., Annaev, T., Kambarov, N., Maksudov, F., & Wang, J. (2022). Morphotype broadening of the grapevine (Vitis vinifera L .) from Oxus civilization 4000 BP , Central Asia. *Scientific Reports*, 1–12. https://doi.org/10.1038/s41598-022-19644-0

Figure 5. Examples of waterlogged archaeological pips allocated by the LDA to the wild and domesticated morphotypes.



Bouby L, Figueiral I, Bouchette A, Rovira N, Ivorra S, et al. (2013) Bioarchaeological Insights into the Process of Domestication of Grapevine (Vitis vinifera L.) during Roman Times in Southern France. PLOS ONE 8(5): e63195. https://doi.org/10.1371/journal.pone.0063195
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0063195





Di Vora e Castelletti 1995 Indagine preliminare sull'archeologia della vite (Vitis vinifera L.) in base ai caratteri diagnostici del vinacciolo, Rivista archeologica dell’antica provincia e Diocesi di Como, 176, 333-358.

ARTICLE

https://doi.org/10.1038/s41467-021-27487-y OPEN

The genomes of 204 *Vitis vinifera* accessions reveal the origin of European wine grapes

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All analyses support a **single domestication event that occurred in Western Asia** (Southern Caucasus) and was followed by numerous and pervasive introgressions from European wild populations

2021

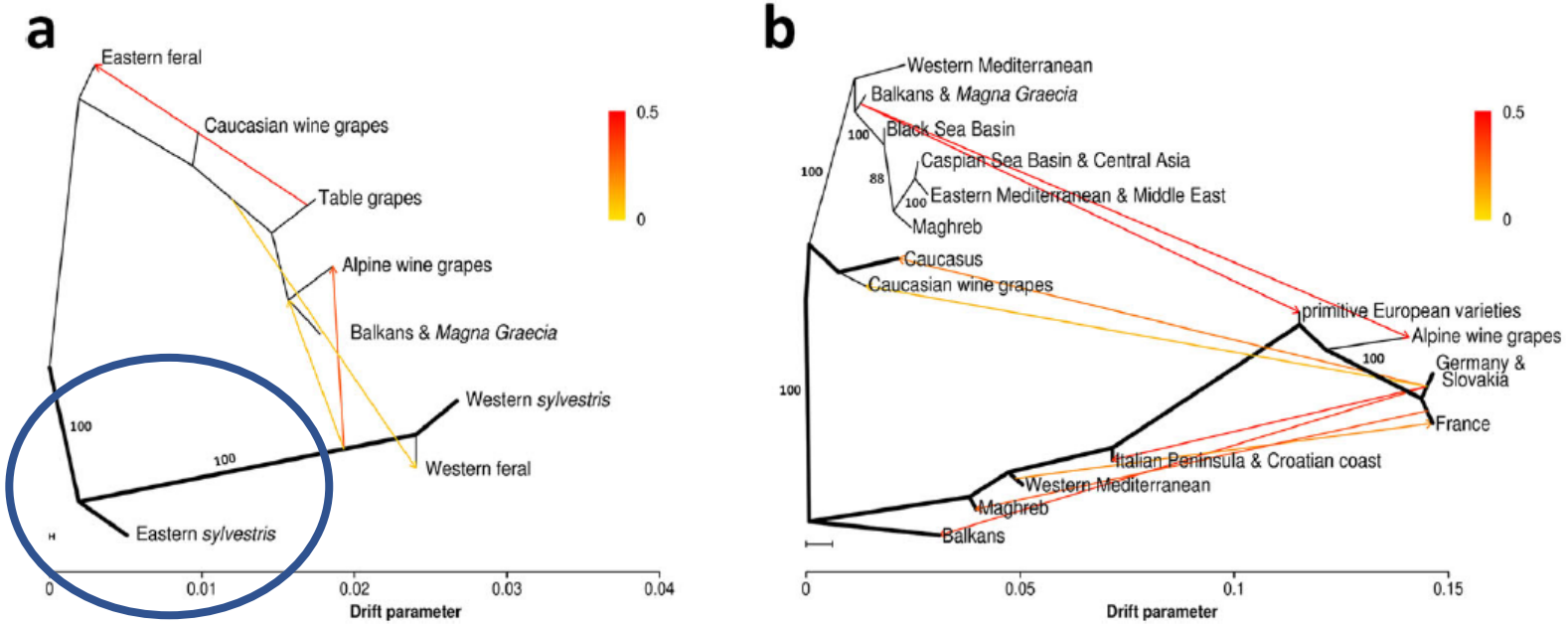
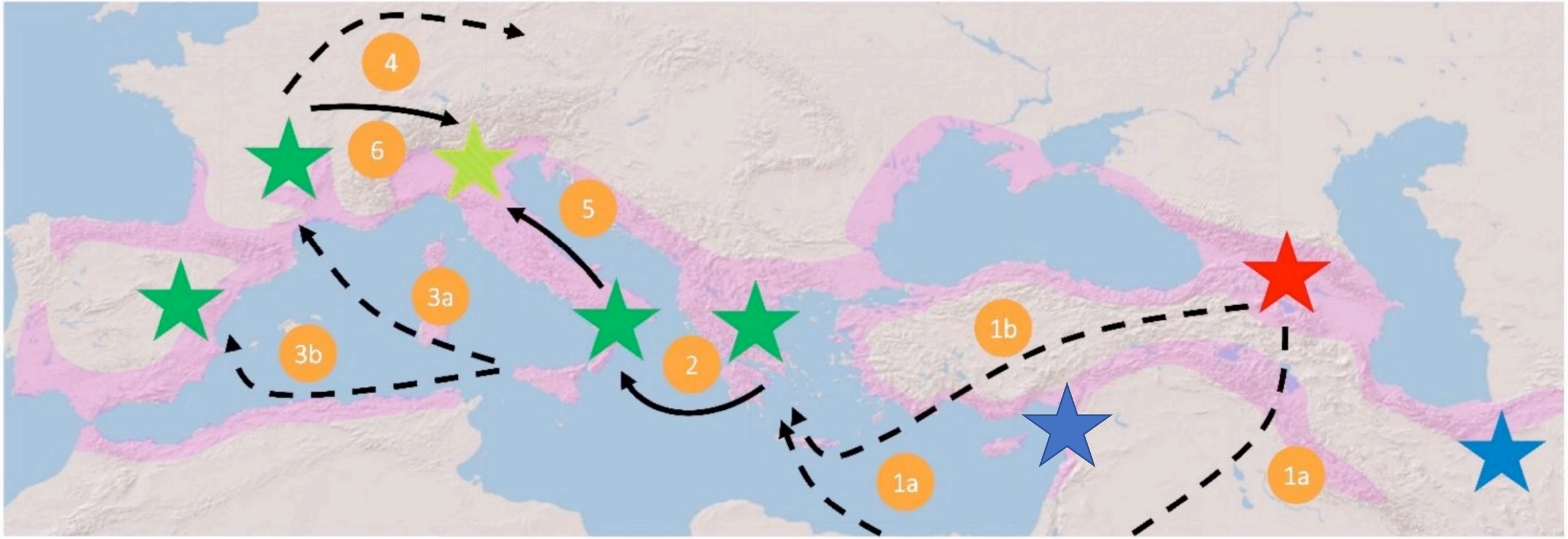


Fig. 1 Split and admixture events in groups defined by population structure in the WGS panel (a) and by geographic distribution in the diversity panel (b). **a** Maximum likelihood (ML) tree with four groups of cultivated varieties (Supplementary Fig. 10) and four groups of wild accessions (Supplementary Fig. 7). Ancestry composition and group sizes are illustrated in Supplementary Fig. 10. **b** ML tree with nine groups of cultivated varieties and seven populations of *sylvestris*. Ancestry composition, group sizes, explained variance and the description of *sylvestris*–*sylvestris* admixture are given in Supplementary Fig. 22. **a**, **b** Migration events are indicated by colored arrows. The color scale shows the migration weight. The scale bar shows ten times the average standard error of the estimated entries in the sample covariance matrix. Bold lines indicate the *sylvestris* branches of the tree. Trees represent random trees and numbers represent bootstrap support values above 70% (100 iterations) before adding migrations. Support for the migration events and the resulting predictive model is given in Supplementary Figs. 20 and 22c, Supplementary Table 1, and Supplementary Data 2.



Primary domestication center

Putative domestication/ diversification centers

Center of admixture

Putative center of domestication

Migration route confirmed by molecular data

Migration route

1a Buono and Vallariello (2002); Marvelli et al. (2013)

1b Paschou et al. (2014)

2 De Lorenzis et al. (2019)

3a Bouby et al. (2013)

3b Buono and Vallariello (2002); Marvelli et al. (2013)

4 Buono and Vallariello (2002); Marvelli et al. (2013)

5 6 De Lorenzis et al. (2019)

Modified by Grassi, F.; De Lorenzis, G. Back to the Origins: Background and Perspectives of Grapevine Domestication. Int. J. Mol. Sci. **2021**, 22, 4518. https://doi.org/10.3390/ijms22094518

PLANT GENETICS

Dual domestications and origin of traits in grapevine evolution

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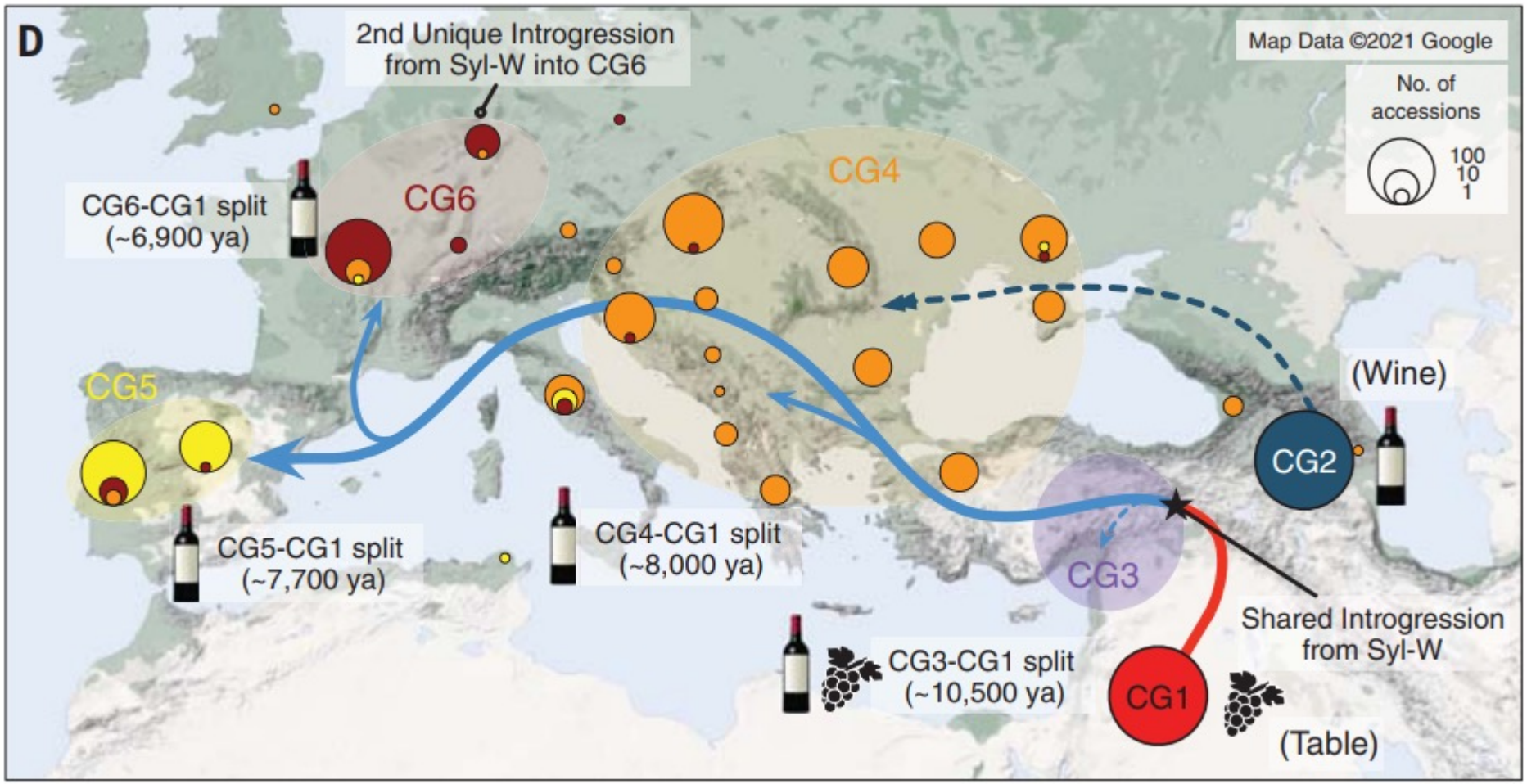

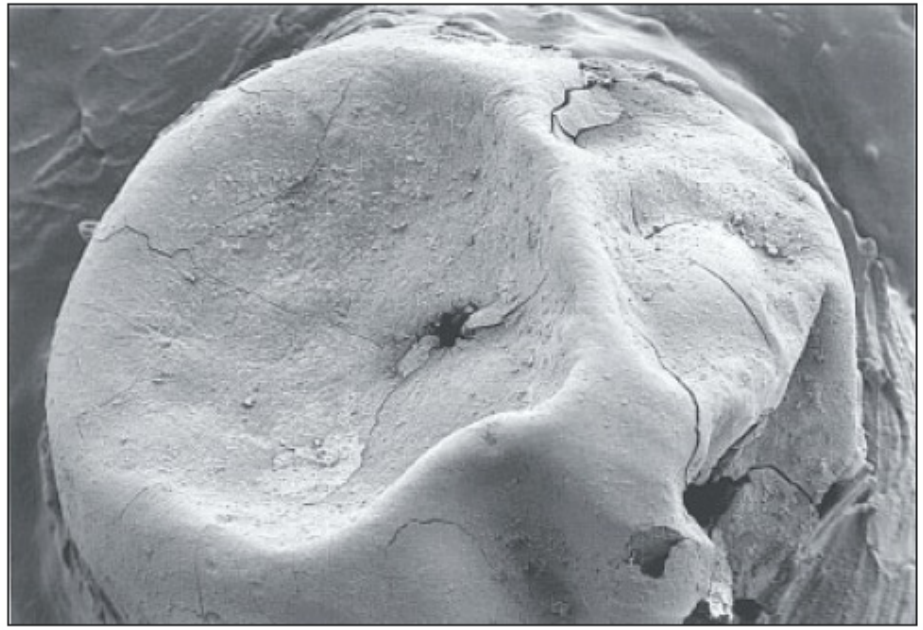

Figure 1 Early Bronze Age charred whole grape or raisin. x11

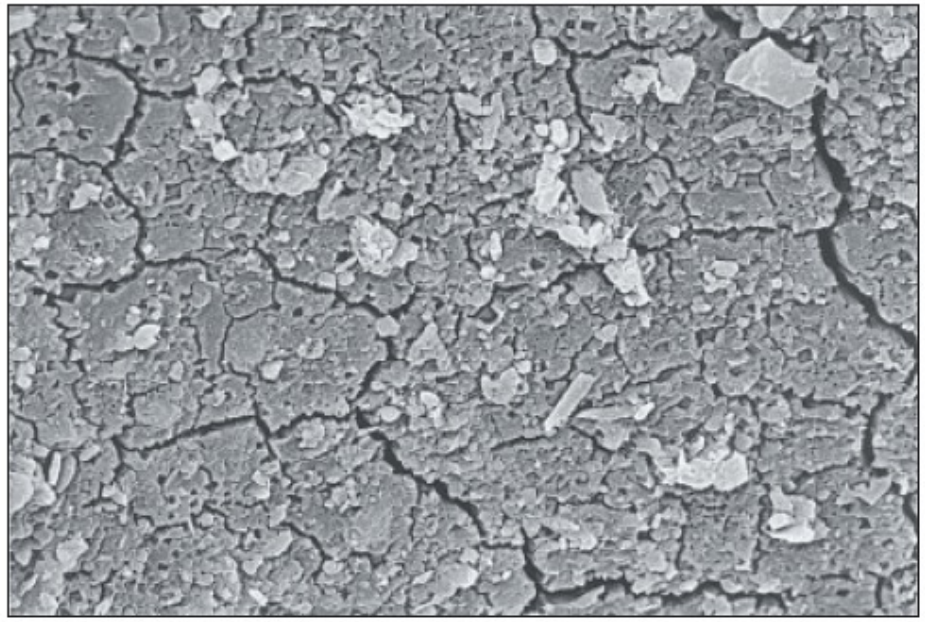

Figure 2 SEM photomicrograph of crystalline features on the grape surface. x1000

Cartwright, 2003 - Grapes or raisins? An early Bronze Age larder under the microscope. Antiquity, 77 , 296: 345 – 348 https://doi.org/10.1017/S0003598X00092322