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Gimbutas' Smile – an archaeology led, archaeogenetic model

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Abstract

Migrations are much more important than currently recognised, for explaining important patterns observed in the European archaeology record – according to this archaeology led model. At a high level, they explain the introduction of different farming, monument building, the spread of metalworking and patterns of trade and exchange.

This paper presents an archaeogenetic model based on a strategic review of the Neolithic and Chalcolithic archaeology of Europe, alongside a review of recently published ancient DNA data. The model is archaeology led. It takes archaeology themes and proposes migratory events to explain them. Ancient DNA data and further archaeology evidence is then used to test these proposed migrations- to reject or refine them.

The model introduces a new and more strategic way of looking at archaeological cultures - that updates early 20th century approaches to studying archaeology cultures, and integrates with the detailed 'post processual' studies of the late 20th Century.

The model consists of seven maps – each showing multiple migration events – with key evidence to support each migration map. It proposes a new category of a 'Black Sea' related population that makes a major genetic contribution to the Middle Neolithic of Europe.

The proposed migrations provide an explanation for the observed patterns of archaeology, for example:

- multiple Neolithic migrations that introduced, farming and metalworking into Europe;
- a major 'Black Sea' related 'Middle Neolithic' migration that carried advanced knowledge of astronomy that can be recognised in a variety of types of monument from the Neolithic through to Bronze Age Europe; and,
- migrations of related cultures ('supercultures') that explain patterns of trade and exchange in Bronze Age western Europe.

The model also provides ancient DNA and archaeology based support for the key aspects of Childe's 'dawn of civilisation' in Europe and Egypt and Gimbutas' 'Old Europe' and "three waves of migration from the Steppe".

Keywords: Archaeology, Archaeogenetic Model, Neolithic, Chalcolithic, Bronze Age, Migration

Introduction

This Archaeogenetic model is led by a review of recent archaeology studies and ancient DNA (aDNA) results. It also references, and builds upon, archaeology models of the 20th century. It proposes new migration events and new linkages between archaeological monuments and cultural memories within the context of migrating and evolving communities.

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Recent genetics based studies have given a degree of certainty that migration events played a major role in the archaeological record of post-glacial Europe (Brandt et al 2013, Olalde et al. 2015 Haak et al 2015). We now know that much of the archaeological theory of the 20th century, from pioneers like Abercrombie (1912), Fleure and Peake (1927,1928,1929), and Vere Gordon Childe (1925, 1950) - based on understanding archaeological cultures and related demic and cultural diffusion - had a degree of validity. The later 20th century focus on post processual detailed analysis, social interactions, cultural diffusion and broad scientific multi-disciplinary studies, has given us new understandings and a great depth of information. However, such a wealth of new material can make it difficult to clearly see underlying relationships. Archaeogenetics can help us stand back to try and tie together the detail within the bigger picture of migrations and cultural interactions.

Leading academics have readily embraced this new agenda with archaeologists and linguists including Cunliffe and Koch (2010), Anthony (2016) Heyd (2017), and Christiansen (2017) giving direction regarding the changing agenda.

Our DNA demonstrates, that although we are all different, our unique personal DNA mix comes from people from many parts of the world, over many millennia. So, for example, a typical European may carry a percentage of DNA from early hominids, such as Neanderthal and Denisovan. As well as their deep African heritage, they may carry DNA from hunter gatherers in western Europe, northern Eurasia and Asia, and farmers from the Levant and Anatolia, and so on through time. Hence, we all share a degree of common history and common memories. It is carried in our DNA and in our wisdom - that has been passed from generation to generation.

Archaeogenetic background

Migrations have been proposed to explain patterns in archaeology for many years. Abercrombie (1912) proposed migrations to explain changes to pottery styles in the UK. Fleure and Peake (1927) proposed migratory links across the whole of Eurasia to provide an account of developing civilisation from the earliest hunter gatherers through to the historic period. Childe (1950) gave his own overview of prehistoric migration in Europe along with his definition of the principles of archaeological cultures:

- Culture is a society of people.
- Culture can be a mix of races.
- Culture can adopt new elements of technology and practices from other cultures.
- Culture can expand or completely move location by the movement/migration of people.
- Culture can expand by diffusion of the ideas and practices without the need for mass movement of people.

Unfortunately, the application of this definition has not always been successful with many examples of cultures that contain different stages of entirely different people and artefacts.

Marija Gimbutas' (1979, updated in 1991, 1993), introduced a hypothesis based on archaeological evidence for 3 waves of migration from the Pontic Steppe into central and western Europe:

- Wave 1 at circa C.4400 to 4300 BCE saw horse riding people equipped with flint daggers, spears and arrows move from the Sredny Stog II culture to eastern Hungary.
- Wave 2 circa 3500 BCE was a wave of migration from the north Pontic Maykop culture transforming cultures into the Carpathian basin the length of the Danube valley, the middle Rhine and the upper and middle Elbe valleys. Over the following 500 years (circa 3500 to 3000 BCE) Gimbutas evidenced changes to the Horgan, Pfyn and Remedello cultures north and south of the Alps and the Rinaldone culture of central Italy and lesser impacts

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further west as far as England and Ireland (Gimbutas, 1991). Features of this wave included stelae, daggers, halberds, and solar signs.

- Wave 3 c. 3000BCE - 2800BCE was connected to the migration of the Yamna people, the associated movement of the 'Corded Pottery' people, and the spread of the Vucedol-Bell Beaker people.

Gimbutas suggests that the spread of Indo-European languages across Europe was linked to these three waves of migration and suggests that the homeland of Proto-Indo-European (PIE), in terms of its spread into western Europe, may be in the area of the Sredny Stog culture.

The three waves of Kurgan migration have proved to be a much-debated theory. It has gained a new level of support from recently published genetic based studies, that have re-established migration from the Steppe as an important mechanism in explaining the archaeological record and the genetic makeup of western Europeans (Brandt et al 2013).

Anthony (2007) provides a comprehensive overview of Steppe societies for the Late Neolithic and Early Bronze Age and explains how he believes the development of the Indo-European languages may be tied in to these cultures. He also has reviewed the genetic context for the spread of PIE (Anthony 2017), and concluded that integration between formerly separate disciplines has changed how archaeologists can approach the problem of Indo-European origins.

Heyd (2017) provides a very good short summary of key ancient DNA (aDNA) publications up to late 2016, emphasising the importance of papers by Brandt et al. (2013); Lazaridis et al. (2014); Allentoft et al. (2015); and Haak et al. (2015). These papers essentially support migration of farmers entering Europe at the start of the Neolithic, and support the Gimbutas wave three migrations - but do not currently support the Gimbutas waves 1 and 2 migrations.

We have recently seen the publication of many new relevant papers and pre-prints. Some introducing large numbers of newly sequenced genomes across large areas of Europe (Lipson et al. 2017; Olalde et al. 2017; Mathieson et al. 2017). Other papers have focused on giving detail about specific regions (Omrak et al. 2016; Kilinc et al. 2016; Martiniano et al. 2017; Tassi et al 2017, and Gonzales-Fortes et al. 2017).

Although the total number of aDNA results is still very limited, these papers provide an aDNA baseline to allow the construction of an outline archaeogenetic model for Europe.

Issues

Academics' archaeological issues

There will be other archaeological issues raised in the Academic arena but this paper focuses on those set out in Volker Heyd's paper Kossinna's smile (2017). Heyd argues that there are 2000 years of interaction between Steppe based populations and more Western populations that are not adequately explained by current genetic based models, including:

- Throughout the fourth millennium BC, there is evidence north and south of the Carpathian arc for close interrelationships between pre-Yamnaya societies of the Steppe and "indigenous cultures".
- Round barrows with individual burials in the Baalberge culture of eastern Germany from c. 3,700 BCE and early horse bones/skulls at the same period and from the slightly later Salzmunde culture.
- New flint and copper daggers and occasional hammer-axes in the West and the graves of men buried with such weapons – warriors.

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- The emergence of anthropomorphic Stelae throughout Europe, including France and Iberia in the late fourth / early third millennium BC.
- Burial practices at Valencina de la Concepcion at 2875 – 2700 cal BC reminiscent of Yamnaya / Corded Ware Culture (CWC) graves.
- Close inter-relationships between pre-Yamnaya societies of the steppe belt and the 'indigenous' cultures both north and south of the Carpathian arc.
- Close interactions between Yamnaya and the Globular amphora culture along the rivers Prut, Dniester, the two Bugs and the San (Szmyt 2013).
- Interaction between Europe and the Steppe goes back as far as the fifth millennium BC to the graves of the Suvorovo-Novodanilovka tradition.

These observed issues may be due to social interaction, migration, or a more complex solution including elements of both. The Model proposed in this paper tests the degree to which migration contributes to these observed issues.

Academics' genetics issues

Issues include (Pala et al 2016):

- Haplogroup H is particularly difficult to understand as there is conflicting evidence about expansion from the near East and clades H1 and H3 expanding from Iberia.
- Evidence in the Balkans suggests early farming Linearbandkeramik (LBK) culture assimilated local I2a2 men but mtDNA is somewhat conflicting showing the appearance of new haplogroups such as H, J1c and K1a3 that originated in the Near East.
- 'R1b remains enigmatic' and in particular branch R1b-L51.

Academics' linguistics issues

Barry Cunliffe introduced the idea that Celtic may have developed as a language in Atlantic Europe from 3000 BCE (Cunliffe 2010). This 'Celtic from the West' hypothesis requires an early arrival of Indo-European language to Atlantic Europe.

Additional citizen scientists' issues

Citizens scientists have raised many issues in relation to archaeology, genetics and linguistics. However, some key issues that relate to their research work on generating the y chromosome phylogenetic tree include the difficulty of explaining the so called 'relict farming populations' of Sardinia and the Pyrenees which have large R1b populations but lack the "Steppe DNA" component that would be expected from R1b being introduced by the 'wave 3' Corded Ware Yamnaya migration.

This has led to polarised views of R1b-L51 migrating with wave 3 from the Steppe versus a Pyrenean or Alpine homeland for the ancestors of R1b-L51 (in a refuge from the last glaciation).

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Results / model

Introduction to the model and maps

A number of recent papers reporting on new ancient genomes, particularly relating to south-east Europe (Mathieson et al 2017 pre-print) and the Bell Beaker people (Olalde et al 2017 pre-print) have made the archaeogenetic picture much clearer. They provide information that enable us to propose models to address some of the issues raised by archaeologist, geneticists, linguists and citizen scientists. "All models are wrong, some are useful" (Box 1979). It is hoped that this model is useful as a foil to recent genetics led models – by raising, arguably subjective, archaeology patterns and challenging the ancient DNA data to provide explanations for them.

The Maps

This model introduces a series of migration maps that can help account for the patterns of archaeology observed across Europe. The maps cover the Neolithic and Chalcolithic with a simplified introduction to the Early and Middle Bronze Age.

The maps also show the major "DNA indicators" that may be used to verify these migrations of people.

Archaeology led modelling

This model (maps and supporting information) attempts to address the key archaeology, linguistic and genetic issues presented in the introduction.

Current genetic modelling puts forward migratory events that can be conclusively demonstrated by ancient DNA data. However, these models have been criticised as far too simplistic to explain the archaeology record (Heyd 2017).

This archaeology led modelling by takes archaeology themes and proposes migratory events to explain them. Ancient DNA data and further archaeology evidence is then used to test these proposed migrations- to reject or refine them.

Archaeology themes and patterns.

This archaeology led modelling takes a very different approach. It works on the basic principle that if we see a spreading of copper tanged daggers, a spreading of bronze rivetted daggers or a spreading of monument types like, bell barrows, or rondels – then a movement of people was probably involved. The pattern of archaeology / possible migration is given primacy in the model and then the aDNA is interrogated to see how it can best explain the archaeology. The model is tested until a best fit with an archaeology led explanation is arrived at.

Some of the archaeology themes selected for this model include:

- patterns of distribution *of enclosures including 'causewayed enclosures and rondels*;
- patterns of distribution of selected **pottery types and related artefacts – such as Gimbutas' figurines and linear pottery** on a Europe wide scale to distribution **of food vessels, collared urns and grooved ware** on a more localised Isles scale.;
- patterns of distribution of metalwork and in **particular tanged daggers, halberds and riveted daggers**,
- patterns of distribution of **dolmen**
- patterns of distribution of **passage graves**
- patterns of distribution of **bowl barrows verses bell barrows, disc barrows** and 'modified types in the Isles.

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Hierarchy of testing

The model has a hierarchy of testing to work through in determining and updating the maps:

1. First pass is the assumption that a pattern is caused by a migration of people.
2. If that does not seem realistic the pattern may be due to a minor movement of people and a higher degree of cultural diffusion.
3. A third pass would be to rule out people movement and rely totally on cultural diffusion - the transfer of ideas without any movement of people.
4. If the first three explanations are rejected the observed pattern is caused by different people in different places inventing the same type of artefact or monument with no other connection.

Multidimensional model

This model is a multi- dimensional system that looks at the patterns across a continent and through a 7,000-year period. A single change to the model, at say 5,600 BCE, may have knock on effect to earlier maps back to 8,000 BCE and following maps – through to 1500 BCE

The model will be developed in more detail and refined by testing. However, it is believed that the current 'first pass' version of the model is broadly compatible with the baseline archaeology information reviewed and is also broadly consistent with current published ancient DNA results.

Modelling Principles

Migrations and DNA. The following migration maps are not meant to be taken literally as monolithic blocks of one male DNA line. Rather the maps are indicative of a presence and movement of a connected group of people where 'indicative' male and female line DNA types (Pala et al 2016) may be indicated on the map.

Thus, the Yamnaya migration on Map four that is indicated as R1b-Z2103 will contain a wide mixture of X and Y chromosome types. For example, the MSY R1b-Z2103 Yamnaya culture also contains I2a2-L702 male line DNA (and more beside). It may be that in certain geographical locations, the I2a2-L702 DNA is the majority but is still recognisable as part of the wider Yamnaya culture.

Similarly, where it interacts with other cultures, such as the Globular Amphora Culture in the area of the Seret, Prut, Dnieper, Dniester River catchments (Szmyt 2013) the DNA mix may be different again. Over time a culture may be overlain by the migration of another group of people or it may merge with others until it has sufficiently changed to be historically recognised as a new and different culture.

Pulses of migration. Most, if not all, migration events, are likely to be a series of smaller movements (pulses) of population movement over a significant period of time– rather than one mass movement of people. For example, the Early Neolithic farming migration 'out of Anatolia' are a number of short lived smaller migrations (Maps 2a,b,c). The model can be refined to give more definition to each pulse but at this pass the model is presenting a 'simplified bigger picture'.

Connections through time. The DNA thread passes on from culture to culture over time, as do memories, skills and learning - through our tangled cultural web, or hyperculture (see section "on cultures" below for explanation of supercultures and hyperculture).

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This Archaeogenetic Model

The following maps and support information constitute the model.

Each map contains coloured arrows depicting important migrations. The text on the map contains characteristic DNA types and is colour coded. The text on the maps sometimes also highlights particular archaeology or culture related to the migration event.

Colour coded. To aid the viewing of this continuity through time, the connected 'supercultures' are colour coded so they can be traced from map to map through time.

In simplified terms the main colours are linked to selected significant archaeological themes and patterns. Each of the main colours represents:

- Green – Early Neolithic Farmers (MSY-G2a) - Gimbutas Old Europe with figurines etc.
- Dark blue – Black Sea hunter gatherers (MSY-I2a2) – astronomical knowledge and monuments such as rondels, passage graves and henges.
- Light blue – dolmen builders and copper prospectors (MSY I2a1).
- Red, Purple, Pink – core 'Gimbutas kurgan wave related' Steppe cultures (MSY R1b, R1a).
- Dark gold –Bronze (and copper) source and 'ancient civilisations' (MSY J2 dominated).

The text below each map introduces the map then provides evidence to support each migration.

Some of the important impacts of these migrations are considered in the discussion and conclusions.

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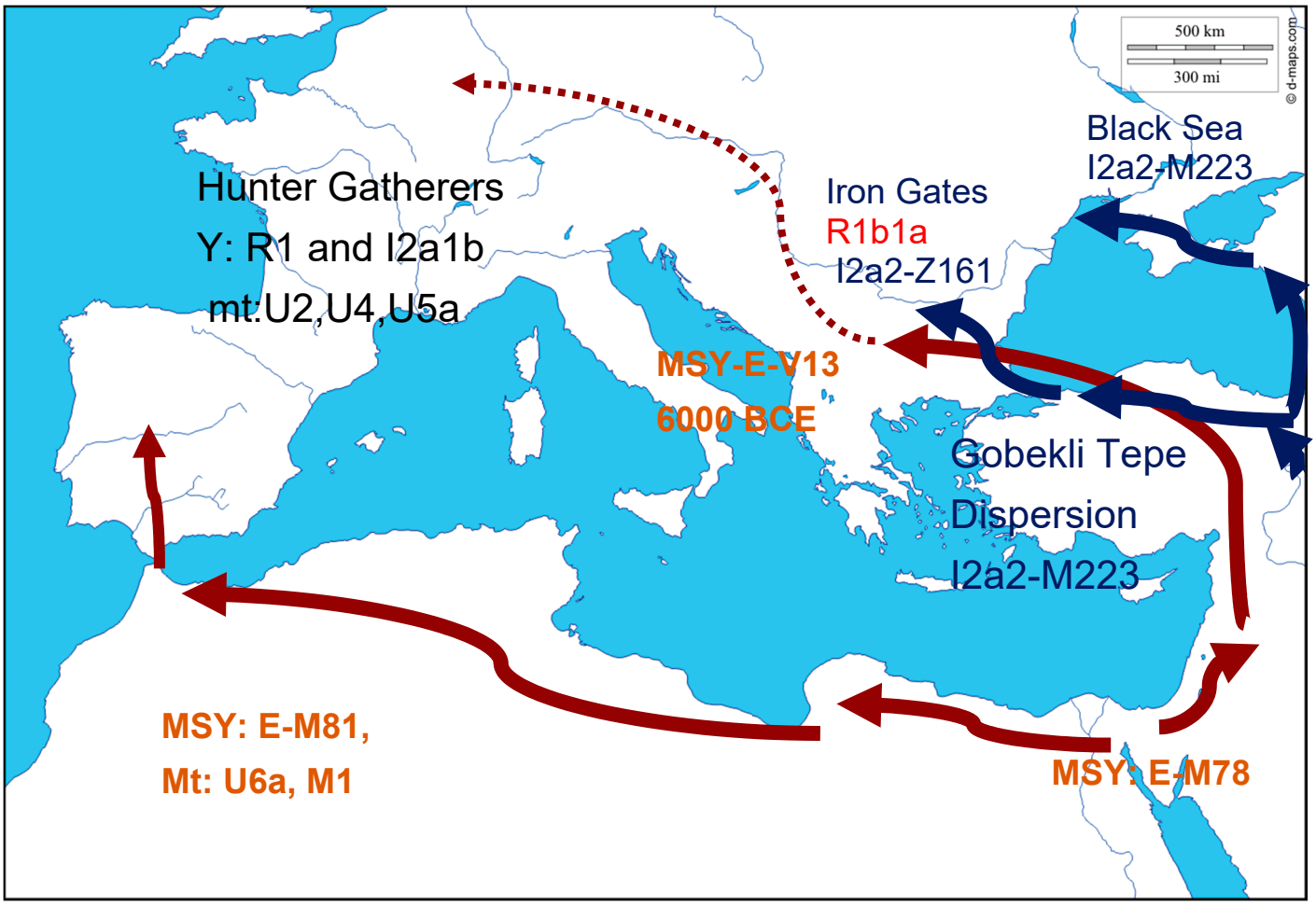
Map 1: Late Mesolithic and Earliest Neolithic migrations (proposed)



Introduction

This map shows a proposed pre-farming migration of MSY E dominated people (brown arrows – dotted means later movement) and a speculative MSY I2a2 movement of people out of Gobekli Tepe (dotted blue arrow) to the Iron Gates region.

Newly proposed Late Mesolithic and Earliest Neolithic migration

Evidence supporting the MSY E migration includes:

- Sites such as Calca and excavations at Ulucak Hoyuk reveal a pre-pottery Neolithic horizon indicating an early migration out of central Anatolia to the Aegean by 7000BCE (Ozdogan 2012 p24).
- Ancient DNA from Morocco shows that MSY E-M81 and mtDNA U6a and M1 were key DNA lines in the early Neolithic and that there was a migratory event into Iberia in the Early Neolithic (map 1) and a reverse migration between the middle and late Neolithic (map 2). (Fregel et al 2017)
- Archaeological studies in southern Spain show that the Moroccan culture spilled into Iberia – "probably due to climate change causing expansion of desert conditions in north Africa" (Cortez-Sanches et al 2012).

Evidence supporting the MSY I2a2 migration. This migration is proposed to provide an explanation for the spread of astronomically related monuments across Europe.

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The migration of I2a2 DNA (blue doted arrow) is supported by the phylogeny and distribution of 12a2 which is consistent with dispersal from Gobekli Tepe region to Iron Gorge (present c. 6,400BCE) and to Latvia (present c. 6000BCE) (Mathieson et al 2017, YFull 2017). This migration carried advanced astronomical understanding, evidenced by the archaeology of Gobekli Tepe (Sweatman 2017).

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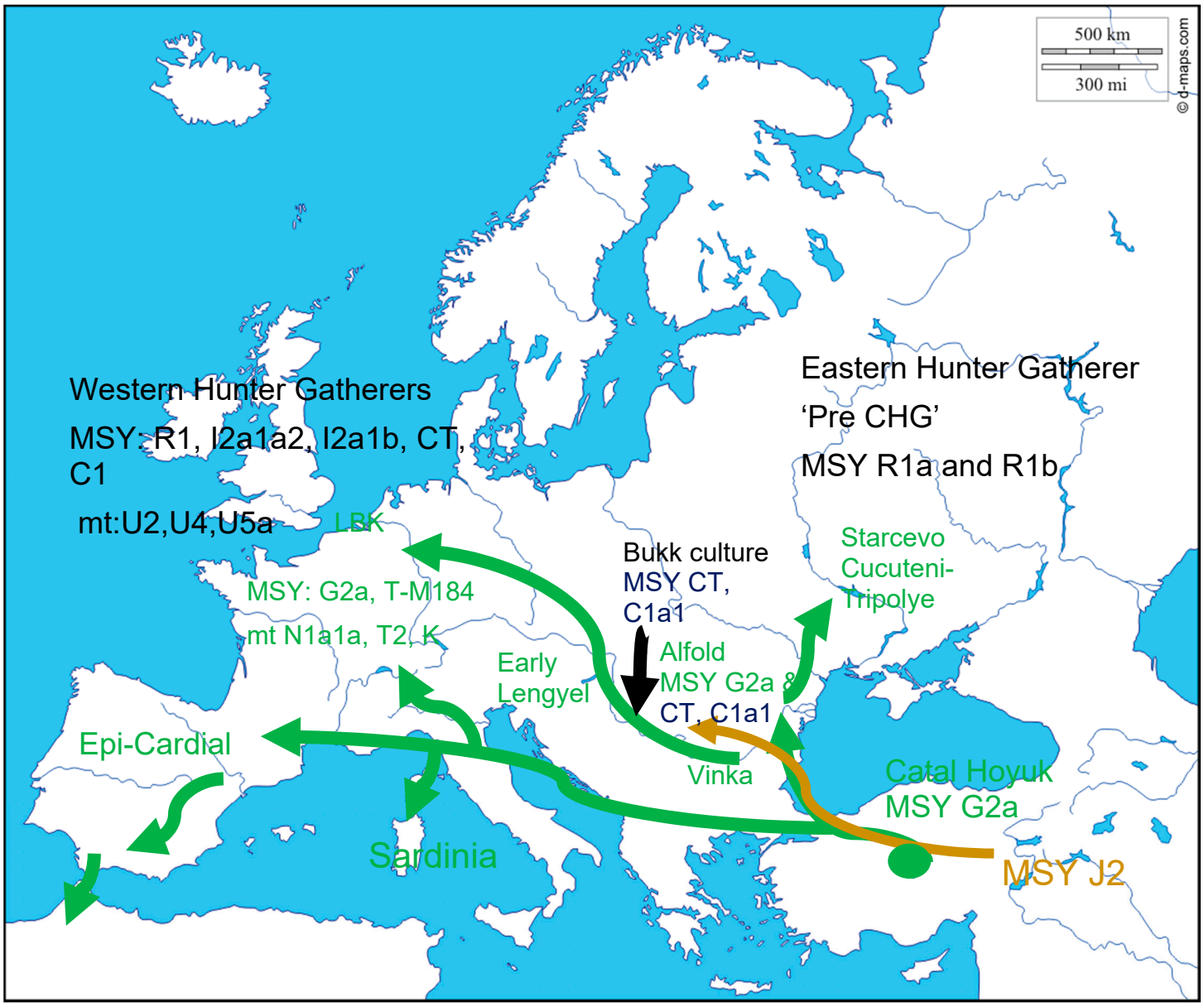
Map 2a: From c 6,300 BCE 'Old Europe' -Early Neolithic farming and metalworking migrations



Map modified after Brandt (2013)

Introduction

This map shows characteristic DNA types of existing western and eastern hunter gather populations (in blue and red), the first major farming migration into Europe (green arrows – dotted is predicted but not currently evidenced) along with a minor migration of metalworkers (dark gold arrows). The initial farming migration was not one mass movement of people but many smaller 'pulses' of movement of differing MSY and mt DNA composition. For example, the Sopot culture (proto-Lengyel and related to the Starcevo and Vinca cultures) that contained MSY J2 and E1b1b DNA (Lipson 2017).

Early Neolithic Farming migration.

An MSY G2a dominated migration (green arrows and text).

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These migration pulses have previously been evidenced by archaeology data:

- as Danubian 1, 1b and 2 (Childe 1950); and
- as a number of small movements of population out of Anatolia, for example, Asagi Pinar layer 6 – clay figurines, painted pottery and tulip vases – "akin to Karanovo 1" and related to separate zone of migration compared to the 'Barcin' (G2a-LBK) migration zone (Ozdogan 2012).

It is proposed that this initial main migration pulse (map 1) formed the Epi-Cardinal, LBK, Starcevo / Cucuteni-Tripolye and Sardinian Bonu Ighinu Cultures of Gimbutas' Old Europe' (Gimbutas 1993).

Additional evidence for this migration includes:

- Pattern of distribution of figurines (Gimbutas 1993), obsidian (Tykot 2002, Gungordu 2010), **Spondylus shells** (Chapman & Gaydarska 2015), **intra mural burials** (Gimbutas 1993, Boric 2015) **longhouses** (Coudart 2015) and **enclosures containing long** houses (Whittle et al 2011).
- This coincided with the abandonment of key settlements at places such as Catal Hoyuk in NW Anatolia. This area is where lipid residues in pottery show dairy products were important by 6,500 BCE - suggesting that dairy related farming had been established (Evershed et al. 2008) and similar lipid residues can be found in LBK pottery in Poland (Roffet-Salque 2015).
- An MSY G2a dominated migration brought farming to much of Europe from Anatolia with N1a1a, T2 and K being particularly important indicator clades (Pala et al 2016, Isern et al 2017).
- Intra-Mural burials extended to Karanovol-II, Kremikovci, Dudesti and Ovcarovo cultures in the east Balkans; Starcevo-Koros-Cris in the east Balkans/Carpathians; and Protoseskl o and Seskl o in the southern Balkans (Boric 2015).
- The migration was first defined in DNA terms by Brandt (2013) with further detailed confirmation following, (Hofmanova 2015, Lazaridis 2016. Isern et al 2017).
- The Epi-cardinal migration in Spain spilled over the Straits of Gibralter and into north Africa (Fregel 2017).
- The arrival of farming was not just one simple wave of farmers arriving together. Three successive waves of neolithisation have been recognised in Transdanubia (Oross 2009).
- The Starcevo (c.5,600 BCE), LBK and LBKT cultures are dominated by MSY G2a (Lipson 2017).

Lipson et al (2017) concluded that transitions to other cultures, such as the Alfold culture, occurred locally because of the mixing between groups of different ancestry. This model supports this proposition because of mixing of hunter-gatherers with CT and C1 DNA from the Bukk culture (map 2b below) who traded obsidian with the Alfold culture (Chapman 2015, Gungordu 2010).

However, this may not be the complete explanation as it is proposed here that there was a following 'Black Sea' migration that changed the genetic profile- currently not recognised in genetic based studies (map 2c below).

Introduction of early metalworking to Europe

Very early bronze working has been identified at the Vinca culture site at Plocnik in southern Serbia where **tin bronze foil** was found next to a **copper** workshop dated to about 4,650 BCE (Radivojevic 2013). It is likely that an early movement of people from the MSY J2 community (dark gold arrow) introduced the first copper and bronze working into the Balkans and possibly the Alps. Early MSY J2 aDNA has been found in the Sopot culture (Szécsényi-Nagy 2015, Lipson 2017)

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and in the LBK culture in Austria (Mathieson 2017). The movement of these people could have been connected with one of the 'three successive waves of neolithization' (Oross 2009) noted above. It is also likely further similar small migrations containing people with MSY J2 DNA followed over the next 2,000 years but this high-level model does not attempt to address those 'minor events'.

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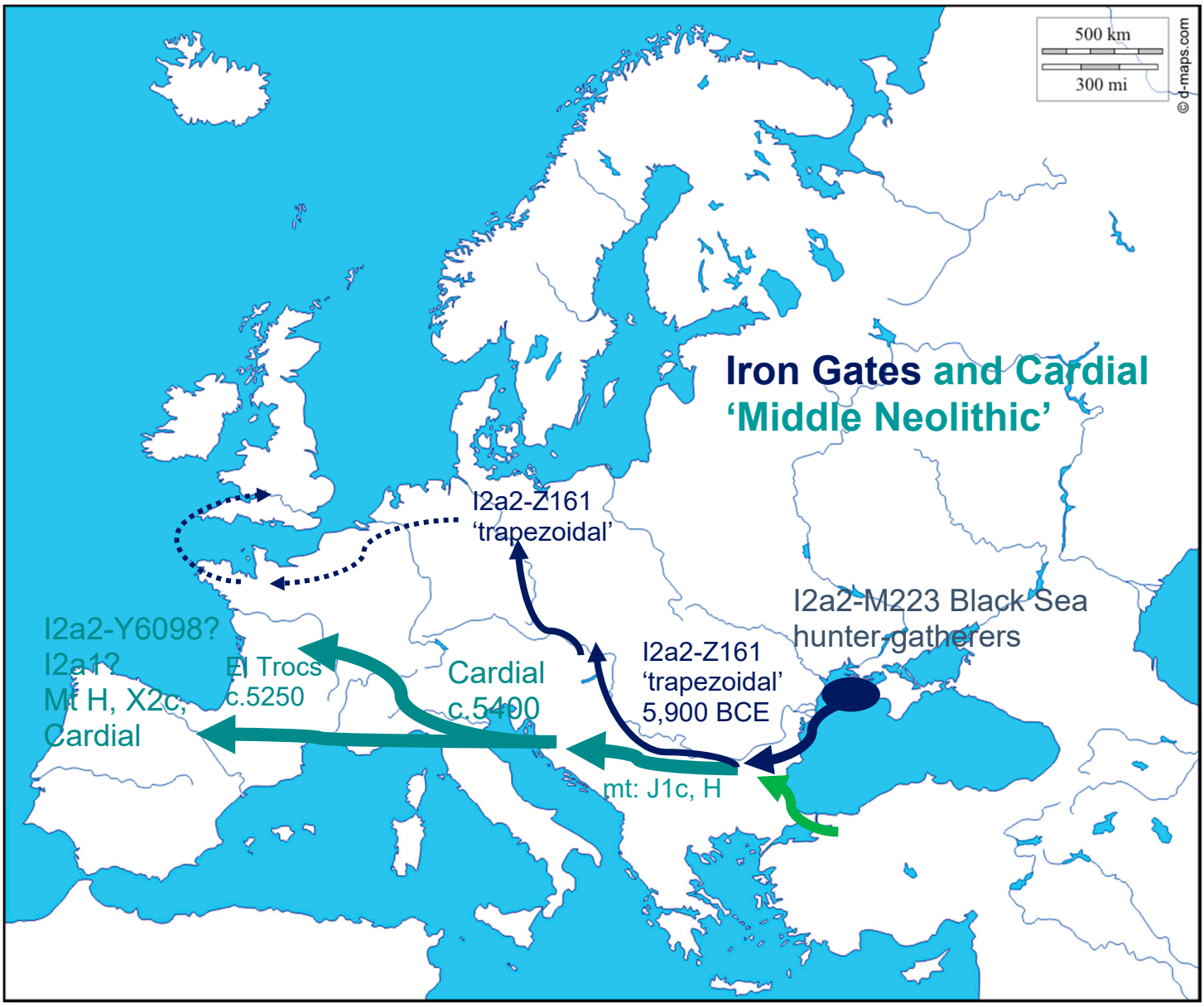
Map 2b: 'Iron Gates Migration' c.5,900 BCE and Cardial 'Middle Neolithic' c.5,400 BCE (proposed)



Introduction

This map shows a second pulse Anatolian farmer (green arrow) / Black Sea hunter gatherer (blue arrow) wave and 'knock on migration effects'. The second pulse Cardinal migrations into Iberia and France are shown by the teal arrows. The thin teal arrow heading north represents a 'knock on' movement of DNA including MSY I2a2-Z161. This is the movement of 'Mesolithic' people from Iron Gates who were displaced by the Anatolian farmers in the Danube Gorges.

The displacement of Mesolithic 'trapezoidal' hunter gatherers

Around 5,900BCE the Mesolithic community, in the Danube Gorge abandoned its **trapezoidal buildings** (Boric 2015) and moved along the Danube Valley and via the Elbe to northern Europe where it spawned a long lasting 'trapezoidal building and burial chamber. Culture. His model proposes that this migration contained including MSY 12a2-Z161 DNA The model also proposes that the long term 'trapezoidal' housing and monument impact can be seen in the Brześć Kujawski

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Group (BKG) of the Lengyel culture, later TRB communities and spreading to northern France by 4,600 BCE and in to the Isles with the Cotswold Severn long barrows in the 4th millennium.

The Cardial 'Middle Neolithic' migration

Around 5,400BCE a significant change takes place to the burial practices in the Danube Valley with the Alfold and Dudustin-Boian cultures showing **complex mixtures of burial practices** (Boric 2015). The **Cardial ware pottery** related migration reached Iberia at this time. It has different mtDNA characteristics, compared to Epi-Cardial (Olalde 2015, Gamba 2014, Lacan 2011a, 2011b) and this model proposes that it is an entirely different migration dominated by MSYI2a2 DNA (rather than the 'green' MSY G2a of map 2 above).

In general, samples from all the Cardinal ware cultures form a middle Neolithic cluster. Samples from later cultures that 'descend or are related' to these cultures – such as the Irish middle Neolithic and Globular Amphora - also exhibit a high 'Anatolian farmer' autosomal component and cluster together in principal component analysis (e.g. Mathieson et al 2017, Cassidy et al 2016). This not only indicates close connections between these communities but also shows they are much more likely descended from Anatolian farmers/Black Sea migrants with some added western hunter gatherer - rather than descended from the indigenous I2a2 hunter gatherer stock.

The admixture analysis, Annex fig 1(Tassi et al 2017) shows a clear differentiation between the LBK farmers (map 1) and European Middle and Late Neolithic populations (Iberia, Globular Amphora - see map 2c below for more detail and discussion section below).

The autosomal aDNA and D statistics of 'Ballynahatty woman' confirm that Cardial farming individuals have very close affinities to Middle Neolithic megalith related communities in Ireland and Iberia (Cassidy et al 2016) – see these further links in maps 2c and 3 below.

Note: The Black Sea has been subject to a major flooding event, possibly around 7,300 BCE, although the date is not certain and others have suggested around 5,700 BCE (Yanchilina, et al 2017). Further rises in the level of the Black Sea mean that it is likely that many Neolithic and Chalcolithic settlements are submerged (e.g. Shepsi – map 4 section below) as several drowned sites have been studied on the Sea of Marmara (Ozdogan 2011 p226). Such flooding events could be one cause of population displacement that is particularly important in this migration.

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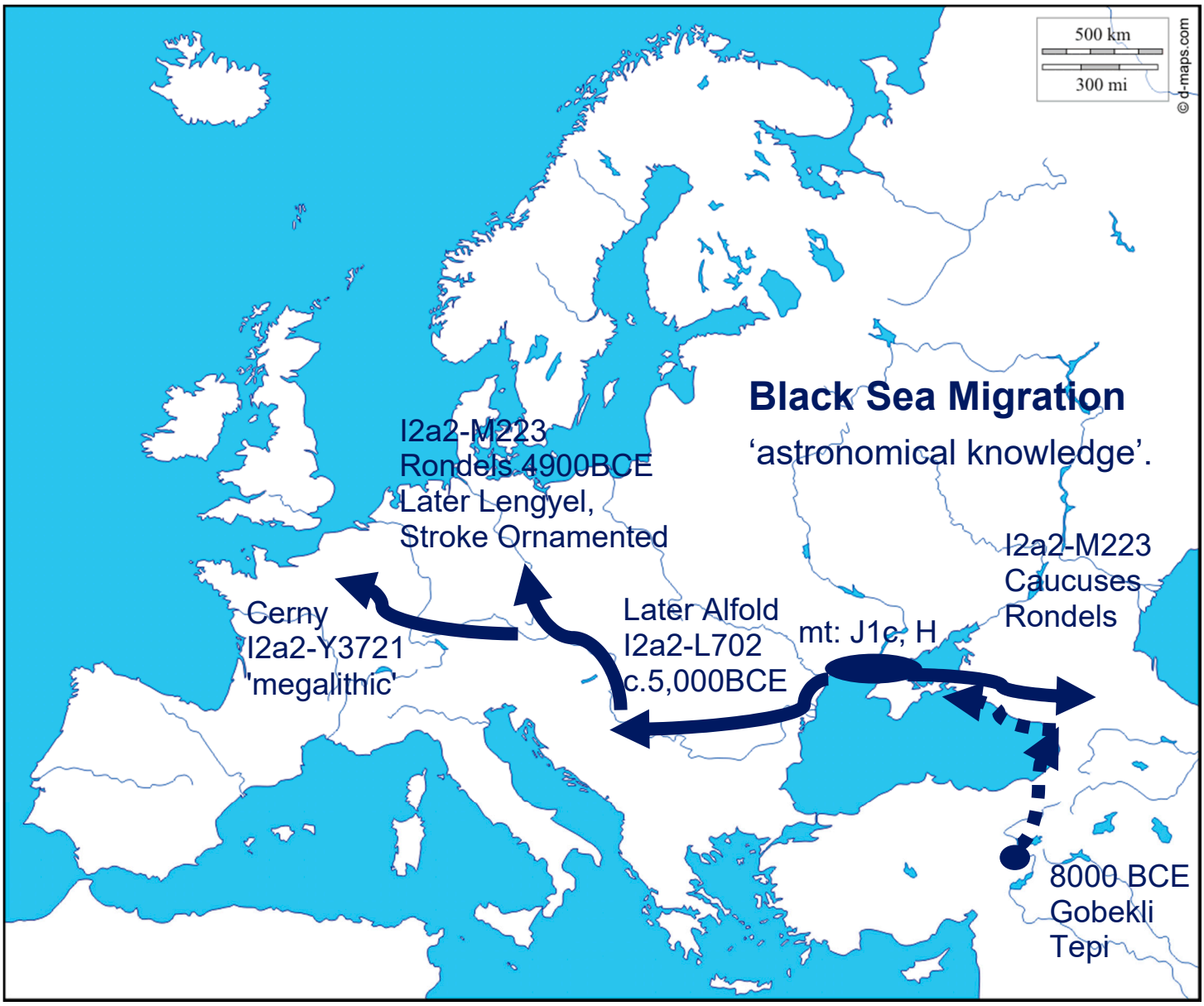
Map 2c: 'Black Sea Migration' From c.5,400- 4,900BCE (proposed)



Introduction

This map is focussed on explaining the origin and spread of the archaeology phenomenon of astronomical knowledge and related monuments where pottery and burial practices diverge significantly from the Early Farmer (map 1) practices.

The map shows a second 'astronomical knowledge' migration that followed quickly behind the above farming migration in map 2. This migration is not currently recognised in genetic based models. It is highlighted on a map of its own so the different branches of the migration can be seen more clearly. Dark blue arrows and text on this and following maps represent migrations dominated by MSY I2a2 DNA. The text identifies particular branches of the migrations that are evidenced separately in the text below. The text on the maps also indicates predicted I2 sub-clades for some of the migration branches along with some key archaeology features.

[The reader may wish to refer to the I2 haplotree as an easily accessible reference to understand the relationship of the tree branches on the maps 2a and 4 - I2 haplotree (Maciamo Hay, Eupedia 2016)].

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Proposed new 'Black Sea astronomical knowledge' migration.

This model proposes that around 5200BCE an additional migration left the area around the Black Sea c.5,200 BCE (I2a2 DNA) to form the Later Alfold (Eastern LBK) culture and inputting to the formation of the Iberian Neolithic and Chalcolithic gene pool (Kilinc 2016).

The LBK types of enclosures and distribution of Spondylus shells in NW Europe (Chapman & Gaydarska 2015), changes significantly around 4,900 BCE when new types of **astronomically aligned enclosures such as Gossec Circle** appear (see map 2c below).

This Black Sea migration has a distinct MSY and mtDNA profile (see evidence below) and distinct autosomal profile that can be clearly recognised in the Iberian Neolithic, Chalcolithic and the Globular Amphora Culture (Annex Fig. 1, Tassi et al 2017).

The 'astronomical knowledge' migration heading west

In general, samples from all these cultures form a middle Neolithic cluster – and samples from later cultures that 'descend' from these cultures – such as the Irish middle Neolithic and Globular Amphora - also exhibit a high 'Anatolian farmer like' autosomal component in the admixture analysis and cluster together in principal component analysis (e.g. Mathieson et al 2017, Cassidy et al 2016). This not only indicates close connections between these communities but also shows they are much more likely descended from Black Sea/Anatolian farmers with some added western hunter gatherer - rather than descended from the indigenous I2a2 hunter gatherer stock.

The 'admixture based on ancient variation analysis, Annex Fig 1 (Tassi et al 2017) further differentiates between the Anatolian farmer and European Middle Neolithic populations leaving the possibility of an entirely new Black Sea source population.

Later Alfold Culture. This model proposes a newly identified Black Sea population that can be recognised by a distinct DNA profile. The Later Alfold culture, has a significantly different DNA profile to the main LBK/LBKT populations.

- It is dominated by MSY I2 with some samples showing I2a2-L702 (Lipson et al 2017).
- I2 samples have a high level of 'farmer autosomal profile' (Gamba et al 2014)
- The presence of mt H, and J1c supports the movement of people from the Near East (Pala et al 2016).

This provides a degree of aDNA support for a 'newly recognised' movement out of the vicinity of the Black Sea, containing, for example, MSY I2a2-L702 DNA – rather than a simple 'taking over' of the LBK population by the indigenous population.

Lengyel Culture.

The early Legyel culture appears distinct from the later Lengyel culture. The early Lengyel contains pottery and figurines that provide a link to Gimbutas' Old Europe.

The Alfold/Eastern Linear group culture ends about 4900 BCE and it is proposed that this group moved because of a new migratory input from the Black Sea region. to form the later Lengyel culture / Stroke Ornamented (and related) cultures. They built many **rondels** such as the Goseck Circle (4,900 BCE) in Germany (possibly later to migrate to Orkney and introduced **henge monuments, and stone and wooden circles with astronomical alignments** (Higginbottom et al 2016) and nucleated settlements around 3150 BCE (Bayliss et al 2017).

The Lengyel culture also has high proportion of MSY I2 DNA along with MSY J2a and H (Lorkiewicz et al. 2015, Szécsényi-Nagy et al. 2015, Lipson et al 2017) suggesting it is a different migrational event to the G2a dominated LBK farmer migration and Early Lengyel.

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Funnel Beaker (TRB). The Brzesc Kujawski Group (BKG) of the Lengyel culture formed a major genetic component of the Funnelbeaker culture (TRB) (Lorkiewicz 2015).

Cerny Culture, France

I2a2 M223 DNA dominated people headed west from the northern Balkans to form the Cerny culture in France – either direct from the Black Sea or a 'knock on' effect with the Black Sea migration displacing a Balkans population. They developed a range of more sophisticated megalithic building techniques found in the **'Passy monuments'** (that they were later to carry north and south along the Atlantic coast where they built **passage graves** – see map 4 below).

The 'astronomical knowledge' migration heading east

It is proposed that a branch of this 'newly identified' Black Sea migration' headed east into the Caucuses. And that this branch was dominated by migration dominated by MSY I2a2 -M223 and mt H - rich in Black Sea Hunter Gatherer autosomal DNA. Evidence includes:

- **aDNA** Samples from the Mariupol community at Dereivka (4800 BCE) contain an 'outlier' sample (sample I3719 MSYI2a2 mtH1 containing an 'Anatolian farmer' (or Black Sea Hunter Gatherer) autosomal DNA profile (Mathieson 2017). This sample suggests that MSY I2a2 person/people entered the Steppe from Cucuteni-Tripolye, Anatolia or an equivalent population adjacent to the Black Sea.

This proposed migration also explains how, for example, mtH1 DNA came into the Steppe (later to be transferred into Eastern Bell Beaker)

It is proposed that these people also carried with them knowledge of astronomy, and related monument construction. They were responsible for building the **rondels of the north Caucuses (**Fassbinder et al 2013). I2a2 -M223 later appear in Yamnaya samples. They passed on their solar knowledge and symbols to the Eastern Beaker people.

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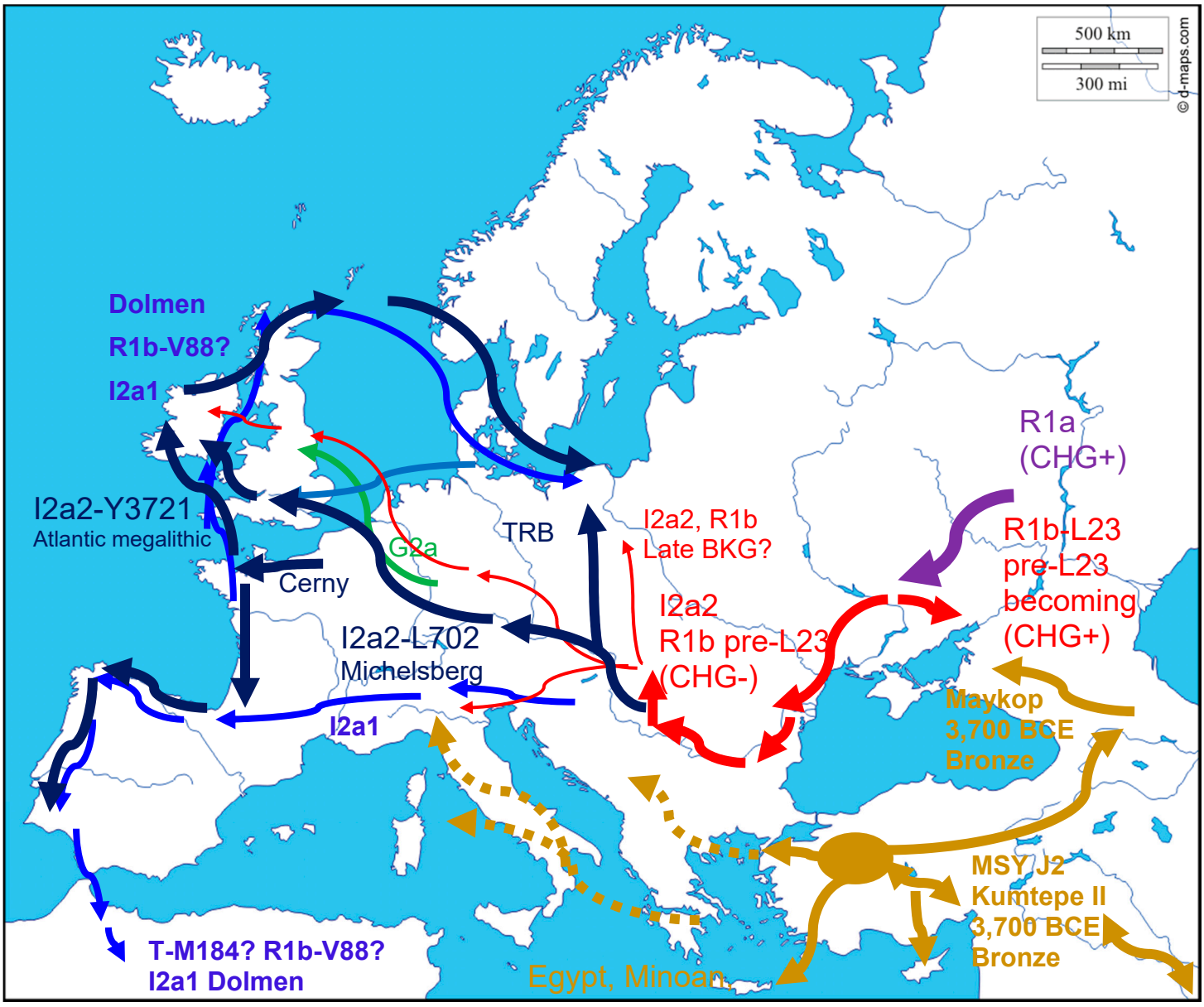
Map 3: 4500BCE Gimbutas wave 1 (modified)



(after Gimbutas 1991, modified)

Introduction

This map is complex. It shows multiple major migratory events around 4500 BCE to around 3700 BCE. The migration in red is the R1b/I2a2 Gimbutas wave one migration with the main migration in a thick line and illustrative extensions to the main migration in thinner red lines. The complex set of dark and lighter blue (I2a2 farming and megalithic communities) and green arrows (G2a farming communities) to the west represent 'knock on' effects of 'wave 1' and each will be briefly reviewed below.

The dark gold arrows can be considered an entirely separate, but equally significant, migratory event. This represents the spread of MSY J2 dominated bronze metalworkers and this event signals the start of the Bronze Age in parts of Europe as the migration and knowledge/skills were slowly distributed across Europe – by demic and cultural diffusion. The rise of the significant

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Minoan, Egyptian and Maykop cultures are a direct result of this migratory event (dotted lines represent the later spread of bronze).

The purple arrow is MSY R1a – to later form Corded Ware

[The reader may wish to refer to the R1b Haplotree (Maciamo Hay, Eupedia 2017) as an easily accessible reference to understand the relationship of the tree branches referred to on maps 3 and 5]

Point of origin for wave 1. Gimbutas proposed a movement from the Sredny Stog culture into the Carpathian Basin around 4500BCE – a date now thought to signal a change in the Dereivka area from the Mariupol culture to the Sredny Stog culture.

A model for Gimbutas wave 1:

Around 4500 BCE R1b (L23) and I2a2 (-L702?) - from around the Dereivka spread area in the Mariupol/Sredny Stog 1 culture - migrated both east and west.

Characteristic archaeological features of this wave include: the appearance of **copper; tanged daggers; shaft hole axes; wild boar tusks**; and, changes to burial practices with **crouched burials in pit graves**.

Elements of this migration continued through to 3,700-3,600 BCE when expansion of the Baden culture blocked its route (see map 4 below).

In the group of R1b left, close to the bottom of the Danube Valley, R1b-L23-L51 formed, where the group remained in small numbers until it became part of the pre-Yamnaya migration up the Danube Valley (see Map 4 below).

Evidence to support wave 1

Evidence includes:

- At Dereivka the local Mesolithic 'oval pit grave population' is a complemented by the arrival of 'sub-rectangular burial with ochre, dolciocranic and mesocranic' population around 5000BCE (Lillie et al 2015).
- Autosomal Caucasian Hunter Gatherer (CHG) DNA arrived at Dereivka by 4200 BCE (Mathieson et al. 2017) and was absorbed into the migration to the east. R1b-L23-Z2103 was formed in this eastern migration and was later to become the dominant male line in the Yamnaya culture.
- The migration west travelled quickly by horse. (Note: the dating of the domestication of horses in Dereivka is still controversial – see Anthony 2007 ch10) and moved up the Danube Valley and the Tisza Valley. This migration comprised MSY R1b (pre-L51) and I2a2 DNA
- Evidence of the migration to the west can be found in the presence of west Pontic copper daggers, gold spirals and pins, heavy hammer axes etc. in the Carpathian Basin - where these metalworking links were maintained from 4,500 BCE until 3,700 BCE (Heyd et al 2015).
- The transition of the Tiszapolgar culture and following Bodrogkeresztur (and Laznany group of eastern Slovakia) cultures from 4,500 BCE with distinctly individual male (right side) and female (left side) crouched burials (Boric 2015) and the associated appearance of sun discs, boars tusks, copper chisels and knives.
- Long flint blades occurred in the late Mariupol and commonly in Sredny Stog sites. These blades appear in the Bodrogkeresztur sites in Hungary and into TRB sites in Poland (Anthony 2007 p247).

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The proposed impacts of wave 1

The proposed impacts are very significant and include:

- Some of the migrants travelled further to reach:
  - the Baalberge culture of eastern Germany from c. 3,700 BCE with early horse bones/skulls with Baalberge aDNA samples showing an 'eastern shift' (Lorkiewicz 2015 fig 3)
  - Liff's Low, Burrythorpe and Duggleby Howe in England and Linkardstown in Ireland where there are kurgan style burials (Gimbutas 1991 p219) – proposed I2a2 dominated migrants.
  - Possibly Northern Italy and the earliest crouched burials – proto-Remedello culture;
- Severe direct impacts and ripple effects causing, for example,
  - dislocation of the Balkan communities including the Vinka culture .(Gimbutas 1993).
  - a migration of I2a1 (and R1b-V88?) dolmen builders into Africa and along the Atlantic fringe in to Scandinavia followed about two hundred years later by;
  - a migration of Cerny 'passage grave building' I2a2-M223 dominated megalithic communities to the Atlantic coast where they moved south into Iberia and north along the west of the Isles and into Scandinavia
  - migration of remnant LBK/Rossen culture into Eastern England forming the large timber hall horizon (McLaughlin et al 2016, at c3,700 BCE (MSY G2a dominated).
  - further mixing of I2a2 migrants with Chassey culture farmers to form the Michelsberg culture (Beau 2017) a 'residentially mobile' farming group (Neil et al. 2016) who migrated across southern England and Ireland building causewayed enclosures from 3900-3600 BCE (and in to northern Europe and south to Portugal);
  - Similar sacrifice burials in Michelsberg (below) and TRB (Gimbutas 1993 p382, Fig 10-29).
  - a migration of Michelsberg related 'carinated ware' people into Bantry Bay forming the house horizon across Ireland (McLaughlin et al 2016, Carlin, N; Cooney, G 2017) at the start of the 4th millennium.
  - pressure impacts in the TRB culture with some TRB people migrating from Poland (4100 BCE) via Denmark (3900 BCE) into the Isles where they built earthen long barrows around 3600 BCE (Bradley et al 2016 P73); and
  - movement of people from Iberia into Africa (Fregel et al 2017)

Michelsberg Case Study

The Michelsberg Culture built causewayed enclosures across north west Europe. It has very different DNA profile to the LBK farmers. It has characteristics that Gimbutas would have attributed to Steppe cultures. For example, burials show a sacrifice culture. Typical male pit burials are in a flexed position with possibly a 'sacrificed wife' of predominately mt H and J in crouched position. Also an adjacent pit with a number of 'sacrificed slaves' - who are of two DNA types - U hunter gatherers and N1a, T, LBK individuals (Beau et al 2017). The European Middle Neolithic "hunter gatherer resurgence" is reinterpreted here as a new 'Black Sea' derived male dominated culture - taking LBK and hunter gatherer slaves who were sacrificed at male leader burials.

The Michelsberg culture is derived from the Cerny culture and Chasseen/Cardinal and the mixing of flows (or in fact one migratory flow enslaving another) results in Michelsberg (Rivollat 2015).

The source of the culture with an mtDNA profile including H, H1, H3, J1 and J2 (very different to the LBK profile) is the Black Sea derived Alfold Culture where the MSY DNA is I2a2 dominated and includes I2a2-L701/702 {Mathieson et al 2017, Lipson et al 2017

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Elsewhere – the formation and spread of the 'Bronze Age' (proposed migration)

This model proposes that the Eurasian Bronze Age spread from Anatolia with the migration of MSY J2 dominated bronze metalworking communities.

It is proposed that element of the migration moved:

- to the north west of the Black Sea contributing to the formation of the Maykop (Jones et al 2015) culture by c.3,700 BCE, initiating bronze metalworking to the Circumpontic metalworking province;
- via the settlement at Alaca Hoyuk, the migration reached Kumtepe by 3,700 BCE with bronze metalworking;
- the Minoan civilisation in Greece (Lazaridis 2017, Eurogenes blog 2017) and leading to
- the Early Dynastic period in Egypt c.3,150 BCE.

A wide range of cultures exhibit similar features of bull imagery including bull leaping. This includes the Minoans, Hattians, Etruscans and Phoenicians and cultural similarities appear in Iberia (Hay 2017).

In conclusion, it is proposed that the MSY J2 network of cultures can be considered a superculture that was the primary vehicle for the introduction of the Bronze Age into Europe.

Note: Very early bronze working has been identified at the Vinca culture site at Plocnik in southern Serbia where tin bronze foil was found next to a copper workshop dated to about 4,650 BCE (Radivojevic et al 2013). It is likely that an early movement of people from this MSY J2 community introduced the first copper and bronze working into the Balkans and possibly the Alps. Early MSY J2 aDNA has been found in the Sopot culture (Szécsényi-Nagy 2015) and in the LBK culture in Austria (Mathieson et al 2017).

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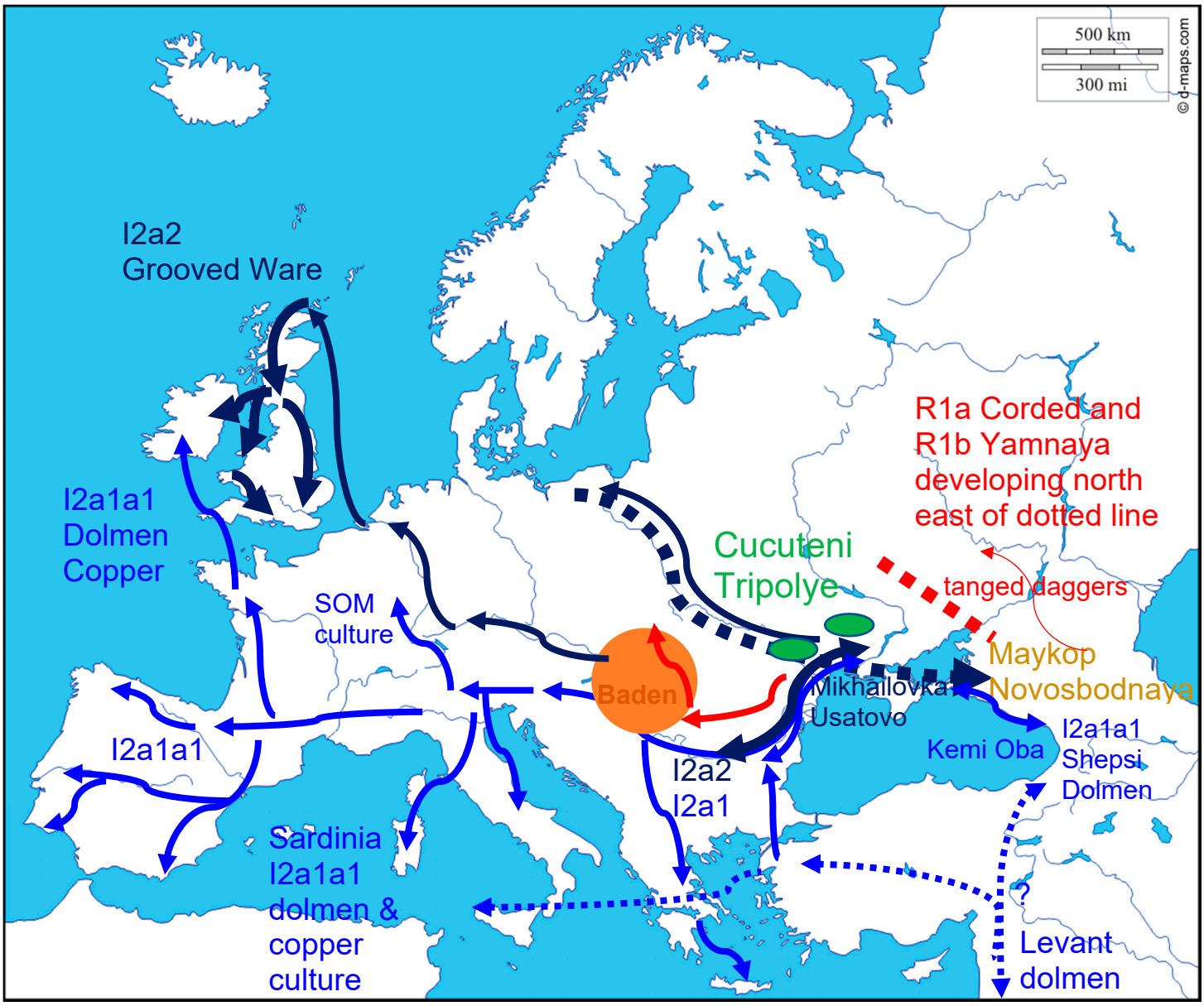
Map 4: c. 3,600-3,000 BCE Gimbutas' wave 2 (modified)



(after Gimbutas 1991 modified)

Introduction

Map 4 shows the (modified) Gimbutas wave 2 migration from the vicinity of the Black Sea (bright blue and red) and proposed secondary events in dark blue. The North Pontic culture / Maykop culture plays a key role in the development and interaction of the 'red and blue' migratory waves.

The wave 2 migration is very complex. The following sequence is proposed:

1. Around 3,600BCE a migration of TRB related people (I2a2-Z161 dominated) into the Steppe to interact with the Mikhailovka 1, **Globular Amphora** using culture and influencing the Novosbodyana element of Maykop (dotted dark blue arrow) – both sharing similar burial practices. Effectively isolating the 'red pre-Yamnaya migration in the Carpathian Basin.

2 A bright blue 'copper' related migration out of the Kemi Oba culture and Black Sea surrounds, with related **dolmen** structures, **stelae and copper halberd and tanged (single riveted) dagger**

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manufacture c. 3,500BCE (Chernykh 1992). Also, the related formation of the Shepsi Dolmen Culture on the north-east coast of the Black Sea.

3. A 'red' 'pre-Yamnaya' movement of (R1b-L51 dominated) people out of the Steppe c.3,400 BCE – with characteristic Pontic **Kurgans** – Mikhailovka 2/3 horizons (Anthony 2007 p320) and the use of **tanged daggers**. This model proposes an autosomal profile similar to the following Corded Ware and Eastern Bell Beaker groups and not similar to the following Yamnaya groups (see Annex figure 1, Tassi et al 2017).

[Note: There is an alternative scenario presented in the Annex (below) where these R1b=L51 groups were already present in the Tisza Valley and in that scenario, there would not need to be this R1b element of the' wave 2 migration'.]

The Mikhailovka 1 people moved back towards the TRB territory forming the Globular Amphora culture that shares pottery styles of Mikhailovka 1 and chambered burial practices found in the Novesbodyana element of Maykop. Novosbodyana/Maykop is central to the Caucasian arsenical bronze metalworking culture and shaft hole axes and double edged tanged knives are characteristic artefacts (Chernykh 1992).

4. Development of the Usatovo version of the Pontic Kurgan culture – dominated by I2a2 DNA (thick dark blue arrow) and controlling the remnant Tripolye culture people. Also isolating the red pre-Yamnaya population in the Danube Valey. The Usatovo **arsenical bronze metalworking** is tied into the Carpatho-Balkan network and manufactured **riveted daggers** (Chernykh 1992, Anthony 1997).

5. Related impacts into northern Globular Amphora (I2a2/G2a dark blue arrow) and north-west Europe France, Ireland (I2a1a1 bright blue arrows) impacts and Orkney I2a2 dark blue arrows).

Evidence to support the Gimbutas wave 2 'out of the Steppe'

It is proposed that the North Pontic culture was central to Gimbutas' wave 2 migration that involved complex interactions between I2a1a1, I2a2 and R1b dominated groups with cultural elements of the Maykop culture appearing in all these groups.

Evidence supporting the proposed sequence of 'wave 2 migration includes:

- The early pit grave (pre-Yamnaya) wave can be recognised by its burials in oval pits and use of crouched burials (Frinculeasa et al 2015) and it is suggested that this migration is well suited to matching Gimbutas' wave 2 migration out of the Steppe (Frinculeasa et al 2015 p84).
- Evidence of horses of larger Steppe type within Cernavoda III and reaching the Baden Culture in the period 3300-3000 BCE (Anthony 2007 p341).
- The migrants reached the Tisza Valley by 3000 BCE with many steppe attributes (Horvath et al 2015) of crouched burials and beaker style pottery that was introduced into the formative Vucedol and Mako cultures – the source area for Maritime and Eastern Bell Beaker.
- Apsidal houses are an innovation found in the Mikhailovka 1 culture of the North Pontic Steppe. They appear in the Vucedol hillfort (Gimbutas 1993).
- The two later Baden (pre-Vucedol) aDNA samples from Balatonlelle contain I2a1a DNA (Lipson 2017)
- The Kumtepe genome Kum 6 has a close affinity to the Sardinian population, although the date for the sample is c4,800 BCE – earlier than this event (Omrak et al 2016).
- The Usatovo culture dominated the remnant Tripolye culture developing separate warrior cemeteries with bronze daggers and axes (Anthony 2007 p350).

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- The Globular Amphora culture contains sacrifice burials (Gimbutas 1993 p328-9). similar to those described for the Michelsberg culture (above) and both have very similar autosomal DNA profiles shown in admixture analysis (Annex fig 1 Tassi et al 2017).
- The pattern of the development and distribution of riveted daggers from the Balkans into the Usatovo culture and the interaction with the Kemi Oba culture (Anthony 1996).
- Evidence of pottery exchange between TRB in south-east Poland communities and Tripolye (Anthony 2017 p360). Anthony suggests that this contact may have spread proto-Germanic language from the Usatovo culture.
- The chemical characteristics of metal from the Usatovo culture corresponds to the north-east Balkans Chernykh (1992 p93).
- Interplay/conflict between the I2a1 riveted dagger superculture and the Maykop/Yamnaya tanged dagger superculture -reflected in the Cotofeni, Cucuteni-Tripolye and Ezero that show successive phases of riveted daggers (I2a2 cultures) replacing tanged daggers (R1b Cultures) or vice versa (e.g. riveted daggers in Cucuteni B, Cotofeni CII and the modified Usatovo culture showing I2a2 presence) (Anthony 1996).

I2a1 migration impacts in western Europe

The migration was a very complex event consisting of a number of consecutive movements of people. These movements include; a movement of I2a1 people related to stelae, halberds and triangular daggers; a movement of I2a1 people related to port hole dolmen; a movement of I2a2 people.

The evidence for this includes:

- The expansion of I2a1a1(I-M26) copper prospectors to Italy (Remedello I), the French Alps and beyond -where triangular 'Remedello style' daggers are represented on rock carvings.
- The migration brought a further wave of I2a1a1 dominated people into Italy (Remedello II) where they introduced warrior stelae decorated with halberds, daggers and other weapons and they practiced Steppe type burials (Jeunesse 2015).
- The further wave extended into the Pfyn and Horgen cultures (Gimbutas 1991) - and possibly contained a distinct group who had links to the Caucasian port hole dolmens and they carried on into France to create the S-O-M culture.
- In Corsica and Sardinia, the Megalithic Dolmen Culture hash astronomical alignments and a copper use.
- Ireland has many dolmens from this period e.g. Ahaglaslin and Arderrawinny astronomically aligned portal tombs close to Mount Gabriel copper mine.
- Ancient DNA samples from the Remedello culture contain I2a1a1 DNA (Allentoft et al 2015 with additional analysis by Tagankin).

Areas that avoided the 'Middle Neolithic' Black Sea migration and other major Steppe related input have distinctive' local' mtDNA profile e.g. Sardinia (Olivieri et al 2017) and have distinct relict copper age language.

At the same time - Orkney

At the same time this model proposes that people dominated by the MSY I2a2 male line– of the rondel tradition – migrated to Orkney. They carried the Orkney vole with them. They initiated a major building phase from around 3,200BCE where they constructed stalled cairns, Maeshowe type passage graves including the monumental complex at the Ness of Brodgar including stone circles and henge monuments (Bayliss et al 2017). The new grooved ware culture expanded to Bru Na Boinne in Ireland where they completed the Newgrange complex and built stone circles

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(Sheridan 2004). They unified the Isles when they extended their control to Stonehenge in England (Parker Pearson et al 2016). (See also discussion section below.)

Speculative Pontic Steppe – Orkney link

The grooved ware culture burial rituals were dominated by new cremation rites, and along with the arrival of the Orkney Vole from the continent and new pottery styles all support the principle of new migrants arriving in Orkney. There are certain features of the grooved ware culture that could suggest a link back to the cultures of the North Pontic Steppe.

- Although later in date, the **henge** monuments of the Grooved Ware culture are similar in style, concept and use to the **Rondel** monuments of Europe and back to the north Caucuses.
- North Pontic Kurgans commonly have a square burial chamber at the centre of a round mound- a square with a circle. Henge monuments have a square at their centre with a circular ditch and bank surround – **a square within a circle**. This includes the early phase of Stonehenge.
- A later '**kurgan with henge ditch'** practice develops in the Wessex culture (see Bronze Age section below) and is derived from the Usatovo culture of the North Pontic Steppe.

Such archaeology elements suggest a possible link through time linking all these elements together. Although these similar elements could be coincidence/re-invention, the principles behind this model call for a proposed link until evidence is found to disprove such links. This proposed speculative link is a radical departure from the commonly accepted explanation that Grooved Ware represents the evolution of an isolated Isles Neolithic community.

It may be possible to test this speculative link in the future with ancient DNA evidence.

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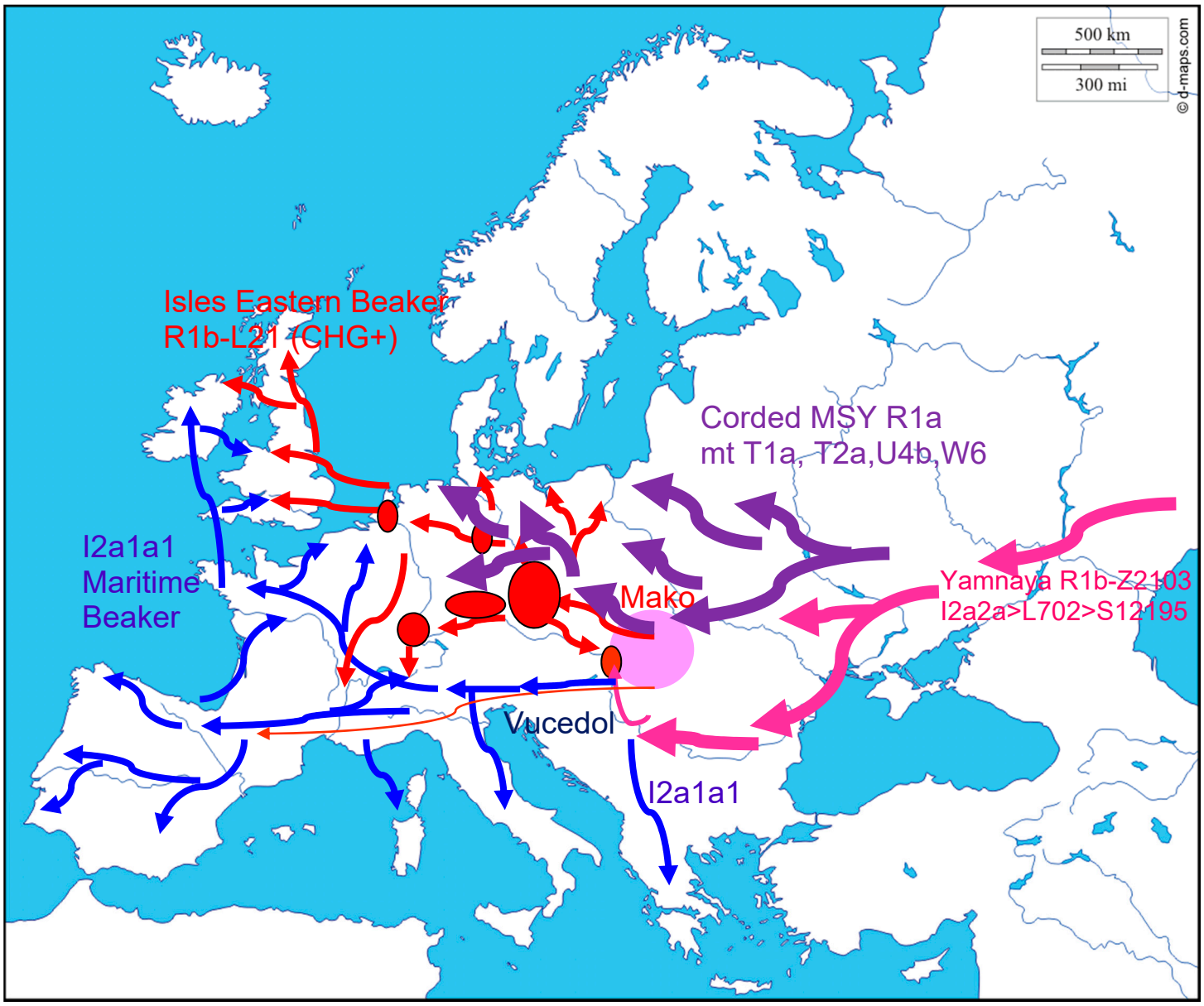
Map 5 – Gimbutas' Wave 3 (modified)



(after Gimbutas 1991, modified)

Introduction

Map 4 shows the Gimbutas wave 3 migration and the related/knock on maritime and Eastern Bell Beaker migrations. The main wave 3 migration out of the Steppe is made up of two parallel migrations. The first 'Corded Ware' migration is to the north of the Carpathian Mountains and is dominated by MSY R1a DNA (purple arrows and text). The second parallel element of the migration is the Yamnaya migration that mainly followed the route of the wave 1 migration up the Danube Valley and into the Tisza Valley. It was dominated by R1b-Z2103 DNA (pink arrows and text).

The 'knock on' Maritime Bell Beaker migration (blue arrows and text) and it can be considered a continuation of the wave 2. The Eastern Bell Beaker is a 'related' but distinctly separate migratory event dominated by MSY R1b-P312 DNA (red arrows and text). Eastern Bell Beaker is not directly derived from Yamnaya as its autosomal profile is very different and more closely related to the Corded Ware stream of migration out of the Steppe (Annex fig. 1, Tassi et al 2017)

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Gimbutas wave 3 migrations

Two parallel waves of Steppe migration entered central Europe after 3000BCE – the R1a dominated Corded Ware migration to the north of the Carpathians (Brandt et al 2013, 2014, Kristiansen 2017) and an R1b-Z2103 dominated Yamnaya migration up the Danube Valley (Heyd 2007, Frînculeasa et al 2015). The Baden culture fragmented into the Vucedol and Mako cultures both containing the proto-Beaker culture.

The formation of Bell Beaker

This model proposes the following:

The approaching Yamnaya migration encouraged the dispersal of the I2a1/I2a2 (proto-) Beaker community west to Italy, Iberia. It then interacted with its R1b proto-Beaker 'cousins' who were still within the confines of the Carpathian basin to form Eastern Beaker. Evidence includes:

Maritime Beaker.

- The 12a1 Vucedol proto Beaker (above) dispersed to Catalonia and beyond where they mixed with the wave 1 PIE speaking migrants to expand as **Maritime Bell Beaker** with I2a1a1 DNA and also wave one MSY early clade R1b and mt H1 DNA (Olalde 2017)
- I2a1 Beaker followed the 'Halberd Bearer people to Ireland (Salanova 2016) where it encountered the 'Halberd Culture. The two groups, represented different beliefs and practices, divided the territories between them (Needham 2016)
- This model predicts that a secondary I2a2 rich Maritime Bell Beaker wave may follow the I2a1a1 Maritime Beakers

Eastern Beaker.

- The R1a dominated corded ware migration passed north of the Carpathians and absorbed the R1b L51> P312 proto-Beaker community that had expanded north of the Carpathians taking the earliest 'Eastern **Corded Beaker'** into Bavaria as their western Europe core area. (Heyd 2007, p367).
- The Yamnaya migration interacted with the Mako Beaker people resulting in them adopting the 'Yamnaya package' and migrating to their Moravian core area (Heyd 2007, Heyd and Harrison 2007).
- These Mako derived Beaker people dispersed to the Moravian province where it followed they (wave 1 formed) pre-Beaker network and quickly expanded to Germany, Bohemia, Middle Elbe-Saale and on to the Netherlands and into the Isles (Heyd 2007).
- Both the Corded Ware and Yamnaya related Eastern Beaker streams gained an autosomal CHG component through their contact (Olalde 2017).
- Both Maritime Beaker and Eastern Beaker reached Sardinia by 2300BC and the resulting mix formed the Nuragic culture that remained little changed into the historic period. Its DNA character is similar to another relict copper age population in the Basque area of Spain.

Further detail is included in the discussion section below.

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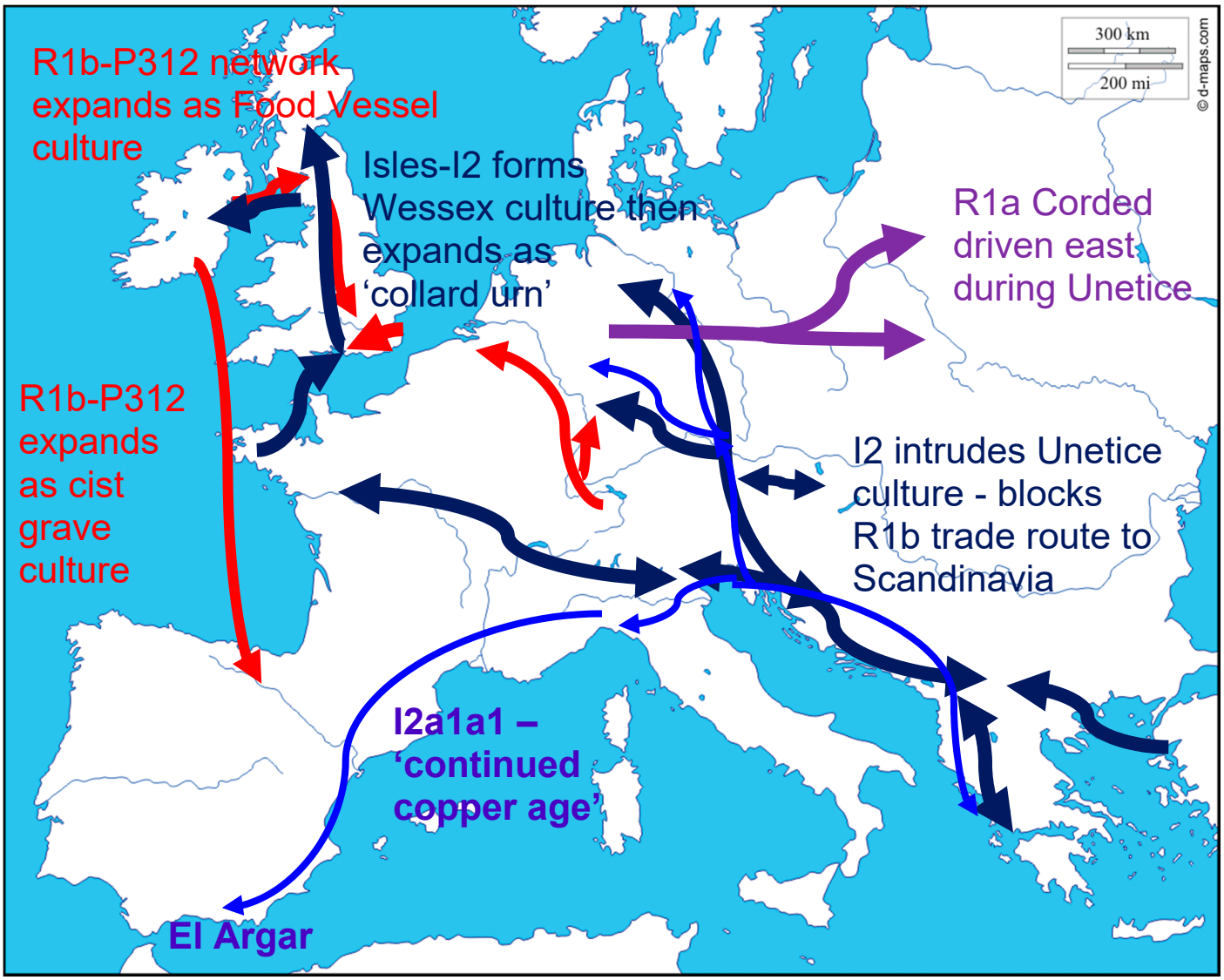
Map 6 – Bronze Age c 2200-1700 BCE (simplified)



Introduction

Maps 6 and 7 are deliberately very over-simplified to illustrate some of the Bronze Age 'big picture' relationships. They need to be supplemented with regional and local models to present a more realistic picture of the detailed events and resulting archaeology record for specific areas (see discussion).

Map 6 shows an initial expansion, around 2,200 BCE, from Ireland of the R1b dominated **Food Vessel** Culture into Ireland and **cist burial** culture towards Iberia. These cultures (shown in red) were directly derived from Eastern Bell Beaker. Shortly afterwards there was rapid growth and expansion of an MST I2a 'superculture' (dark blue) that displaced much of Eastern Bell Beaker (red) and Corded Ware (purple) cultures in western Europe.

Sequence of changes in the Isles and continental Europe

This model proposes this sequence of change in the Isles:

- Around 2200-2100 there was a starburst of R1b>L21>Df13 sub-clades signalling a rapid expansion of the post Eastern Beaker, Food Vessel culture that started in Ireland and expanded. It took control of the central Irish gold resources and Ross Island copper mine

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(previously controlled by the I2 superculture. (Poznik et al 2016, Flood 2016) and expanded across Scotland and England. This period is referred to as the fission stage (Needham 2005).

- The arrival/formation of the I2 dominated Wessex culture – strongly linked to Armorica, n-w France (later to expand north as the related Early Bronze Age **Collared Urn** culture). The I2 bronze age culture has characteristic **riveted bronze daggers** (Piggott 1937, Gerloff 1975) and has primarily a cremation based funerary system (making aDNA analysis difficult).

This model proposes this sequence of change in continental Europe:

- C.2,500- 2200 BCE Beaker network has a north-south network of metalwork trade between Scandinavia and the Alps as Bell Beaker and Corded Ware co-exist.
- Corded ware evolves into Early Unetice (Deideri 2008) including inward migration of new groups with MSY I2a2b and I2c which are autosomally closely related to the Corded Ware and Eastern Bell Beaker populations (Tassi et al 2017) – Annex fig 1.
- C. 2150 BCE the N-S Bell Beaker network is progressively broken as the I2a1 dominated Early Unetice culture creates a marked change to culture and genetics (Desideri 2008, Massey et al 2017) It displaces Bell Beaker from its territory.

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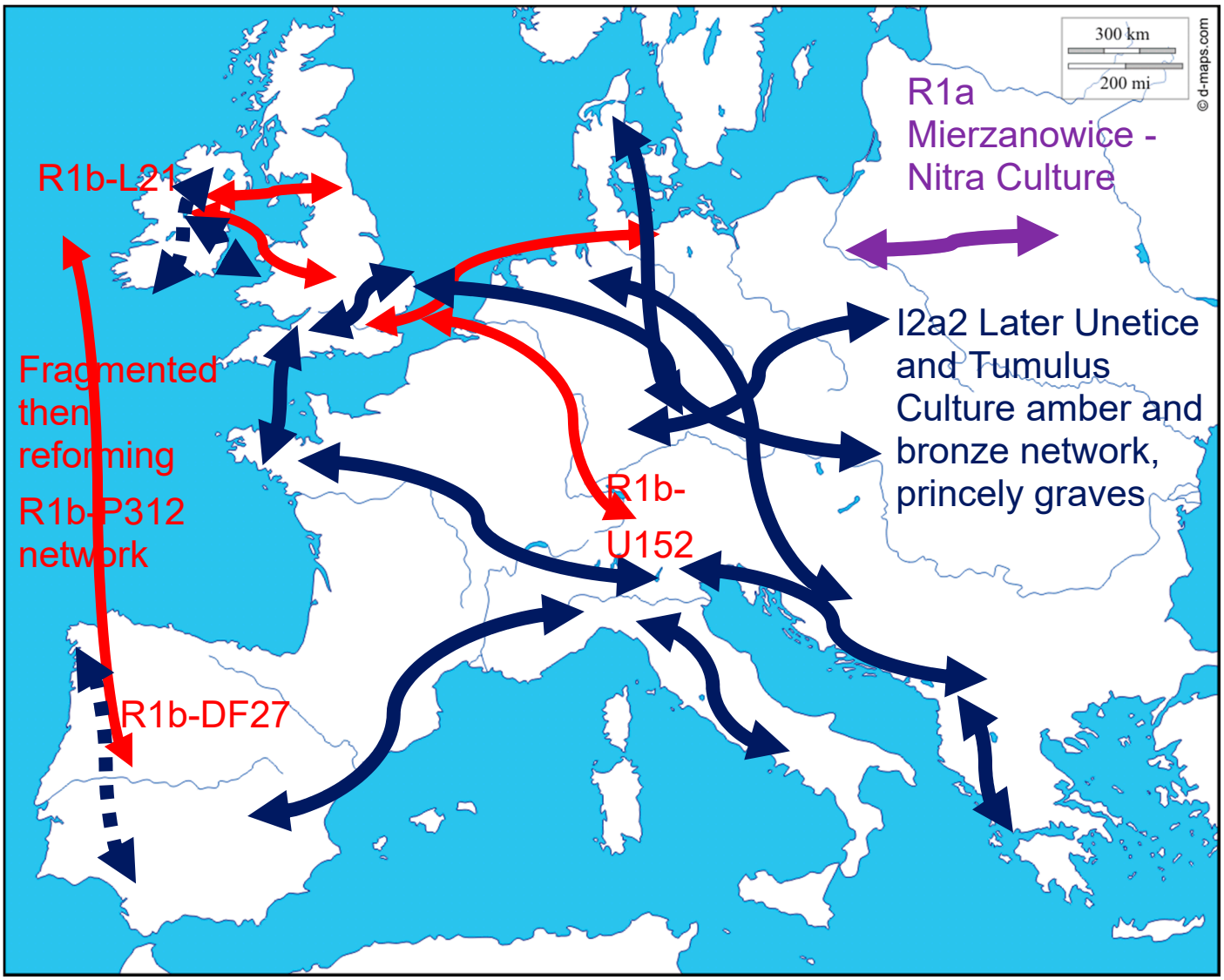
Map 7 – Bronze Age c. 1600–1300 BCE (very simplified)



Introduction

This simplified mid-Bronze Age map show the continued development of the I2a superculture (blue) and shows its extensive cultural trade and exchange network. However, by 1600 BCE the Atlantic R1b network (red) was re-establishing its control of the Atlantic zone setting up new trade networks and ultimately the 'Atlantic Bronze Age' network.

The Expansion of the I2 superculture network in western Europe.

Evidence for the distribution and growth of this superculture includes:

- The distribution **halberds** can be used as a proxy for the territories occupied by the I2a1 'copper age' element of the superculture (O' Riordain 1937).
- The movement of the I2a1 element across territories over time can be plotted by the appearance and disappearance of halberd use over time (Needham 2016 p45) aided by refined radio-carbon dated chronologies for Europe (Stockhammer et al 2015).
- Thus, as the I2a1 superculture developed in the Carpathians, northern Europe and the El Argar culture it had already 'waned' in Ireland and Portugal where the R1b-P312 **'cist burial'** culture was expanding.

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- The I2a2 element carried Bronze technology. It may contain a J2a component of MSY DNA. It spread from the Eastern Balkans and Aegean (Heyd 2013) and can be recognised by the presence of **bronze riveted daggers**.

The model proposes this further sequence of change:

- C 1900 BCE the I2a1 superculture becomes established in Germany, for example in the Lech Valley (Massey et al 2017).
- From c. 1700 BCE), the Unetice copper based culture (I2a1a1) is succeeded by the 'tin-bronze rich' (Massey 2017) Bronze Age I2a2 superculture network (map 6 above) forming the Wessex – Germany—Czech- Carpathian network (with 'princely graves') and also linked northwards north to Scandinavia and south to the Mycenae in Greece.
- C 1650 BCE. Break down of the Isles element of the I2 superculture as a second L21>DF13 sub-clade starburst event takes place in the Isles (Flood 2016). R1b domination of new copper working and tin production (Great Orme, Cornwall) and re-expansion into Wessex squeezing I2 Wessex culture to small core chalk upland enclave. Decline of I2 Iberian culture.
- C 1500-1300 BCE R1b-P312 developed network - trade route from Alps to UK to Scandinavia.
- C. 1300 BCE completion of R1b-P312 network to Iberia and transport of Iberian ores to Scandinavia along Atlantic – "the Atlantic Bronze Age". Also linked to the Alps via the Rhine with Cliffs End, Thanet a key 'meeting point' McKinley et al 2014).

Bronze Age (Simplified) Conclusion

The interactions of the three MSY I2, R1a and R1b dominated supercultures, enables an explanation for:

- The Early Rib-P312 beaker trade route from the Alps to Scandinavia – through 'permeable' Ria Corded Ware enclaves. – prior to the I2 superculture formation of the Unetice 'blocking' culture.
- The advent of the Bronze Age via the Mediterranean contacts of the I2 superculture. Resulting changing trading patterns of amber, faience, copper, bronze, and related weapons and objects (Childe 1950, Gerloff 1975, Ling et al. 2012, 2014). This created links between Bretton 'dagger graves', the Wessex culture of southern England (Piggott 1938), and 'princely burials' in, for example, the Czech Republic. The reasons why objects like the Sky Disk of Nebra (Meller 2016) were created by this culture is because of the I2 superculture millennia long link to astronomical knowledge.
- The Middle Bronze age resurgence of the R1B-P312 superculture created networks - the Alps-Isles-Scandinavia route for distinctive objects/metals – followed by the further expanded Atlantic Bronze Age network.

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Discussion of options and issues

Options

This model is not 'fixed' and different 'what if scenarios' can be added to explore alternatives.

Example option - Gimbutas Wave 1

An example of an option for Map 3 – Gimbutas wave 1 – is included in the Annex (below) as an illustrative example.

Even without considering options, the current model raises a number of **issues** worthy of discussion:

Issues:

Black Sea Hunter Gatherer and Black Sea Migrations

This model is proposing a radical re-interpretation of currently published PCA and admixture analysis (Mathieson et al 2017, Tassi et al 2017).

Current interpretations are based on the I2a2 Mesolithic populations being long term based in Latvia and Iron Gates. The phylogeny of I2a2 CTS 10057 (Latvia HG c.5,500 BCE) and branches Z161 (Iron Gates c. 6,500) and L702 (Ukraine Mesolithic c. 5,500 BCE) is interpreted as I2a2 being very widespread in the Early Mesolithic. Their formation date and TMRCA of around 8,000 BCE (YFull) requires them to have spread from a common point of origin around 8,000 BCE – not currently discussed in publications but perhaps presuming a spread from Latvia or from Iron Gates.

This model is suggesting a radically different interpretation that is led by the need to provide an explanation for the spread of astronomical knowledge and a wide range of related monuments (rondels, passage graves, henges, stone circles).

This model suggests that the earliest advanced astronomical knowledge and monuments can be found at Gobekli Tepi. And that a population of (newly proposed) 'Black Sea Hunter Gatherers' lived at Gobekli Tepe and migrated to the edge of the Black Sea and to Iron Gates – prior to its catastrophic inundation. The model proposes that the phylogeny of I2a2 can be equally well explained as spreading from the Black Sea area in the Mesolithic and Neolithic periods.

It is proposed that the Black Sea hunter gatherer component can be recognised as being within the distinctive dark green component of the 'admixture analysis based only on ancient variation' of Annex fig 1, (Tassi et al 2017). This model proposes that the Black Sea element can be seen in Early Neolithic, Middle Neolithic and Chalcolithic Iberian samples and in the Globular Amphora Culture.

The key implication of this is that the 'classic European Middle Neolithic' autosomal profile is not just Anatolian Farmers with extra local hunter gatherer resurgence. But that the European Middle Neolithic also has a large migratory input from the Black Sea hunter gatherer I2a2 population – certain groups carrying astronomical knowledge and monument building techniques.

Steppe cultures and Steppe DNA – inadequate definition

The implication of this is that the current definition of Steppe DNA - containing a GHC component - is not adequate when using the definition to support Middle and Late Neolithic migrations into central and western Europe.

It is proposed that during the Middle Neolithic there were large areas of 'Steppe culture', in the Lower Danube and adjacent to the Black Sea that remained largely free of any CHG autosomal

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component. These communities are related to the Black Sea migration complex and are dominated by I2a2 DNA. They are largely CHG free / low CHG component such that:

- the I2a2 'Middle Neolithic' Black Sea migration out of the Steppe was free of a CHG component (for example Later Alfold and Michelsberg cultures); and
- the R1b-L51>L11 pre-Yamnaya wave of migration may not have had uniform CHG component such that early migrants may have had a lower percentage CHG component than later arrivals. This may be reflected in the lower CHG component in some of the 'outlier' Eastern Bell Beaker samples.

Remedello and Bell Beaker

The model identifies probable genetic continuity in the Remedello culture, from Remedello 1, (triangular daggers), through Remedello 2 (halberd) to Maritime Bell Beaker. The genetic continuity with the I2 DNA grouping, along with the lack of autosomal CGH, would lead to a prediction that the Maritime Bell Beaker group would show close affinities to the 'riveted dagger tradition'.

However, the situation is complex:

- Remedello Culture and Bell Beaker exhibit many 'Steppe characteristics from weapon types, burial styles and use of stelae.
- Needham (2016) has suggested that the 'Halberd bearers' were spatially divided from the Bell Beaker population.
- In Maritime Beaker in Portugal, there are complex spatial divisions between the 'indigenous' chalcolithic population, Beaker groups with incised pottery - and Beaker groups with finer maritime beakers who 'took over' the old fortified settlements (Cardoso et al. 2014).
- The latter group also used tanged daggers – a characteristic of the Maykop/Yamnaya tradition and linked to the Eastern Beaker stream of this model (Cardoso et al 2014).
- Two Paris Street, Barcelona, samples (Olalde et al. 2017) are R1b with no autosomal CHG (samples I0261 R1b1axR1b1a1a2a /U5b1i and I0257 R1b1 / H1ax) and could reflect a local Mesolithic indigenous population or they could be a match for the proposed Gimbutas wave 1 migrants that reached Catalonia. This needs to be resolved.

Cultural diffusion could be used as an explanation for Yamnaya like practices and metalwork being present in Maritime Beaker. But as the model does not provide a period of contact between Yamnaya and Maritime Beaker, this explanation does not sit well with this model.

So, prestige goods supplied through the Beaker network may provide the solution (perhaps a fundamental statement of allegiance – as the halberd may have been to indigenous groups (Needham 2016). However, neither of these explanations is considered adequate:

As a **preferred solution**, this model is currently proposing that the use of tanged daggers is related to 'Eastern' wave 1 or 'Eastern Beaker. So, that 'Maritime Beaker' with tanged daggers is likely wave 1 I2a2/R1b DNA that reached Iberia.

As a preferred solution Remedello I, Remedello II and 'I2a1a1 Maritime Beaker' can all be considered Anatolian linked cultures (possibly not Indo-European speaking – as reflected in Sardinian and Basque cultures). Any wave 1 related Rib and I2a2 tanged dagger Beaker can, along with Eastern Beaker, be considered Steppe cultures and probably (Proto or) Indo-European speaking.

Bell Beaker archaeogenetic model

It would be possible to construct a detailed archaeogenetic model for the evolution of Bell Beaker to address the above issues. However, this will be more effectively done once the final version of

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the Olalde et al. (2017) paper is published and there is access to the genome archive – and is beyond the scope of this paper.

Bronze Age Europe

Maps 6 and 7 of the model are deliberately very superficial – to illustrate the potential of the modelling to explain patterns of metalworking, trade and cultural similarities across western Europe.

The detail of the archaeology on the ground is far more complex for many reasons including:

- Through the Neolithic, Bronze Age and Iron Age, more and more mixing of populations and cultures occurred meaning that looking for distinctive DNA types and distinctive patterns in archaeology becomes progressively more complex.
- Cultures live side by side and interact with each other or may be in conflict for control of territory.
- Cultures and supercultures do not fit into defined archaeology timescales, so it is possible that:
    - One culture or superculture moves location over time, possibly seemingly disappearing from the record and re-appearing elsewhere some time later.
    - In principle a 'Mesolithic' hunter gather community could be living side by side with a 'Neolithic' farming community and also side by side with a 'metal ages' culture at a single point in time. An example of parallel communities has recently been published for the Bronze Age in Germany. In Augsberg, what was originally considered successive time periods BZ A1 and BZ A2, actually reflects two distinct overlapping cultures that lived side by side for a period of 150-200 years (Stockhammer et al 2015).

The Bronze Age maps need to be complemented with more detailed regional and local archaeogenetic models (see future developments below).

The Wessex Culture

The Wessex culture has been identified as an important distinct Bronze Age culture in southern England (Piggott 1938) with key characteristics that include the:

- use of riveted daggers;
- use of bell and disc barrows that 'might almost be described as barrows with an added henge element';
- location of clusters of bell and disc barrows close to important Neolithic henge monuments such as Stonehenge and Maumbury Rings (Dorchester, Dorset).

Conflict between users of 'Beaker barrows' and 'Wessex barrows', for example close to Stonehenge at Net Down, has been documented in detail (Martin 2011).

The model explains these phenomenon as the Wessex culture is modelled as a continuation of the I2a2 superculture and it is at the interface (point of conflict) with the R1b superculture.

This is similar to the situation at Sion in the Swiss Alps and Aosta in the Italian Alps (Harrison and Heyd 2007) where this model proposes that I2 and R1b supercultures were in direct conflict

Language

For language, we may predict from the model that:

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- To understanding the development of PIE it is important to understand population movements between the Steppe and Anatolia – and not just look for a single one-way linear movement out of either the Steppe or Anatolia.
- In understanding how/when Indo-European language reached western Europe we need to consider:
  - Waves of movement out of the Steppe before the Gimbutas wave 3.
  - The importance of I2a1 and I2a2 male dominated 'multidirectional' population movements between Anatolia, the Steppe and Europe.
  - That Indo-European could have reached the western Europe before Bell Beaker – through the I2 superculture network. For example, the proposed Black Sea Migration that travels from the Steppe to the Danube (Alford Culture – Map 2a) and later into the Isles and northern Europe as the Michelsberg culture (Map 3).

Hence, if Indo-European was spoken in the Steppe adjacent to the Black Sea, the language could have been transferred to large parts of Europe during the Middle Neolithic period.

Culture and memory

In looking at language development we may also wish to consider Indo-European and Celtic myths. The Irish Lebor Gabála Érenn (Book of Invasions) has descriptions that tie together language and landscape. It was written down in the 7th Century CE as a record of Ireland's history that had passed through the generations by word of mouth.

It has been suggested that the meaning and usage of Newgrange was passed down through legend and practice for 5,000 years (Carey 1990) and the Irish myths suggest Celtic was spoken at Newgrange at the time of the Beaker People (Koch 2016)

There are many elements of the myths that reflect migratory events to Ireland in this model, for example:

- *Cessair first people to arrive in Ireland at Bantry Bay* - Granny c3,800 BCE inland of Bantry has the earliest identified Cardinal Neolithic settlement in Ireland.
- *Partholon battle and defeat the mysterious Fomorians and then suffer from Plague* – proposed wave 1 and wave 3 migrations from the Steppe into Ireland would likely have have carried Y. Pestis (Rasmussen 2013) – including its confirmed appearance with Eastern Bell Beaker (Valtuena 2016).

This proposed support for the Lebor Gabála Érenn being based on memories directly related to factual events could be important because:

- it potentially demonstrates that the cultural history of these people was transferred by word of mouth for thousands of years before it was written down;
- It potentially supports the use of the myths as a source of understanding of historic events and language development; and
- It potentially supports the proposal that cultures can carry memory, and wisdom for thousands of years (Carey 1990). And that transfer of that 'memory' is very important for understanding patterns of: social interactions; artefacts; technologies; monument building; beliefs; and practices through millennia.

The Irish Lebor Gabála Érenn would lend itself to a detailed exercise to see the extent that events described myths could be correlated with an archaeogenetic model for Ireland.

Re-invention or continuity across space and time

This paper proposes that we should look to better understand the relationship between recurring patterns of monument building and social practices - across continental scale distances and

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millennia in time. It proposes that although re-invention may well occur, in many cases similarities may be due to the DNA and memory thread that runs through and across our supercultures – or our one hyperculture.

The Shepsi Dolmen culture

The "Shepsi Dolmen Culture" is named here as the culture inhabiting the area between the Novosvobodnaya culture (related to Maykop) and the north-east coast of the Black Sea during the second half of the 4th Millennium BCE (Trifonov 2014). It is characterised by port hole slab dolmens and beaker like pottery.

The port hole slab graves have similarities to features found in the Globular Amphora culture and later in the S-O-M culture in France and places like Los Millares in Iberia (Childe 1950). [See Trifonov 2014 for discussion of theories about possible links between Shepsi, Novosvobodnaya, Funnel Beaker and Globular Amphora.]

It is proposed here that these relationships are not re-invention of similar archaeological features but are connected via the I2a2 superculture network. Further archaeology and aDNA information would allow this model to more fully address these relationships, and – will help refine this model.

The Grooved Ware culture of Orkney/Isles

To understand the population dynamics of the Late Neolithic and Early Bronze Age of the Isles it is important to resolve - in detailed aDNA terms (particularly I2 sub-clades) - the relationship between the following speculative archaeology links:

- the aDNA of Grooved Ware people and middle Neolithic/Michelsberg cultures;
- the aDNA of 'wave 1 crouched burials in the Isles' e.g. Duggleby Howe;
- the origins and links of cremation practices in the Later Neolithic of the Carpathian Basin and north-westwards including Grooved Ware people (Kosko 1995);
- the aDNA of Bronze Age Wessex culture; and
- possible Orkney links to the Mediterranean due to similarities between apsidal structures and alter/dresser features of Skara Brae Village and the temples of Malta and Gozo (Gimbutas 1993 p177, Orkney Jar 2017) and apsidal structures in Mikhailovka 1 and Vucedol hillfort (Gimbutas 1993)
- possible links between North Pontic Kurgans commonly that have a square burial chamber at the centre of a round mound- a square with a circle – and, henge monuments that have a square at their centre with a circular ditch and bank surround.

Understanding the degree of DNA continuity through these cultures is important to resolve:

- apparent similarities in archaeology connecting the Isles middle Neolithic with the Bronze Age Wessex culture and the following Collared Urn culture; and conversely
- apparent extreme differences between the 'Gimbutas' megalithic Old Europe' and the 'Kurganised Steppe' Wessex culture that introduced Bronze technology to the Isles.

This model proposes that all are part of the I2 superculture - and gathering new data to better understand the superculture transition from 'Old Europe' to 'Kurganised Bronze Age' - will help refine this model and the accuracy of Gimbutas' defined scope of her Old and Kurganised Europe.

Updated and refined model(s)

This paper presents what is currently a 'simplified, high level model'. It can be refined by, for example, adding in 'screened out' DNA types such as MSY I1 and I2c and adding those related interactions. Also by adding new 'archaeology patterns, and to seek a DNA related explanation for them.

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This type of model can be developed and applied at a global, continental, regional and local levels. Such models can be useful for explaining patterns of archaeology and then testing those explanations in using science based methods.

Conclusion

Archaeogenetic modelling can provide an independent framework for science based testing of archaeological theory.

This paper provides an outline archaeogenetic model that addresses, and supports:

- Gimbutas' three waves of migration out of the Steppe and her related concept of Old Europe (though disagreeing with the detailed timing and distribution);
- the 'spread of civilisation' across Europe and into Egypt (Childe 1925, Peake and Fleure 1927) and Gimbutas' 'Old Europe' (Maps 2 and 3);
- the concept of the Wessex culture in southern England and its links back in time to the builders of stone circles, henge monuments and Stonehenge (Piggott 1938);
- long term memory being carried through cultures – across continents in spatial terms, and through millennia in time (Carey 1990);
- newly identified migrations (particularly maps 2b and 2c – the Middle Neolithic Black Sea migrations) as an important consideration in the development and spread of Indo-European languages; and
- the models 'relationships within and between supercultures' as explanations for patterns of monuments, artefacts, exchange and trade in Bronze Age western Europe.

This experimental model can be developed in more depth and detail from existing research material. It can be further tested and developed through new multi-disciplinary research including the relatively new science of ancient DNA analysis and archaeogenetics.

This approach to archaeogenetic modelling can usefully be applied at a pan-continent, regional, sub-regional, and local site levels.

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Method

Formation of the current model

This model began in 2013 as an attempt to provide a migration explanation for cultural changes, from the Neolithic to the Dark Ages, for the sites at Bestwall (Ladle 2012, Ladle and Woodward 2009) and Worth Matravers (Ladle forthcoming). The DNA content of the model in 2013-2015 was largely predicted due to lack of aDNA sample results. The early attempts to model these migrations – and how that can be related to living people through their own DNA - was presented to the Purbeck Society in 2015 (see appendix) (Kenyon 2016) The model attempted to address mapped patterns of distribution of monuments and artefacts (e.g. Cunliffe 2013).

The current modelling relied on review of literature (primarily archaeology plus available ancient DNA information), but particularly relied on exchange of learning / research across the citizen science network such as the Anthrogenica Forum and Eurogenes Blog.

The model is also based on an understanding of the Y chromosome phylogenetic tree developed by citizen scientists. Key to the modelling is to try and understand when and where particular branches of the haplotrees formed and so help trace the movements of those 'extended families' over time.

For example, if we wish to understand the 'enigmatic R1b' and branch L51 so we can trace its migration history we can refer to citizen science projects and discussions, such as:

- The formal International Society of Genetic Genealogy (ISOGG) haplogroup tree for R1b
- The basal subclades of R1b that lead up to L51and show its connection to brother clade Z2103 in the Steppe who at the time of its formation was located in the Steppe.
- Below L51 we can look at particular branches such as P312 (that has been found in Eastern Bell Beaker. Past examples of the development of these trees can be seen here (Walsh, ongoing)
- Next generation sequencing has allowed the development of the P312 'Big Tree' through to living individuals – also showing their relationship to relevant ancient genomes (Williamson ongoing).
- Citizen scientists have developed different methodologies for predicting the date of formation of branches of the haplotrees. The Y Full experimental tree is often used as a reference point and has been used in this modelling exercise as a source of predicted formation and time of most recent common ancestor dates.
- Relevant citizen science discussions and sharing of ideas and knowledge, for example, the Anthrogenica discussion thread "Bell Beaker, Gimbutas, and R1b" and blog discussions on "late PIE ground zero"

Understanding periods when particular clades suffered bottlenecks and starburst expansions help identify rapid growth phases for certain haplogroup clades (Poznik et al 2016). This can be applied in more detail to particular haplogroups and clades of interest in attempts to understand their spread in more detail (Flood 2016) and this data can perhaps be best applied and understood in the context of an overall model.

The current version of the model resulted from a logical deduction exercise from trying to understand the impacts of the Halberd Culture (Needham 2016) on the Isles and the logical conclusion that an unexpected DNA type was central to the Wessex culture after release of the Olalde pre-print (Olalde et a.l 2017).

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The rest of this model developed from a logical deduction exercise – applying that learning/principle to the author's understanding of the archaeological record and Y haplotree – particularly the R1b and I2 trees referred to above.

The author's understanding of both the archaeology record and current aDNA data is very limited compared to the joint understanding of the wider archaeogenetics community. Hence there is opportunity for that community to test, reject, or suggest radical changes or refinements to this model, even without the need for any new aDNA samples.

Future Development

It is possible to test and update this model with:

- Current multi-disciplinary evidence unknown, or known but not understood, by the current author.
- Forthcoming multidisciplinary evidence - particularly new aDNA data as it is a new science and currently the number of samples is limited, but growing rapidly.

Hierarchy of models

It is desirable to develop complementary archaeogenetic models on different geographical scales because they provide feedback for the development of each individual model. This macro scale model was produced as part of an iterative process of developing:

- a regional model for southern England in the context of western Europe and:
- a local model for two multiperiod sites in the Isle of Purbeck, Dorset, UK.

Further work on those models will also contribute to refining this 'macro scale' model. Archaeogenetic models could be developed for many archaeology sites or sub-regions. The models may provide a greater depth of explanation and understanding of the pattern of archaeology.

On Cultures

In this paper it is suggested that it is helpful to revisit the idea of archaeological cultures - but in a new way that includes an understanding of our complex and inter-twined social interactions. So we can think of a' Halberd bearers' culture (Needham 2016) that links several historic archaeological cultures such as Remedello, Argaric, and Unetice). The cultures existed in different times and places with different mixes of people/DNA. But they appear inextricably linked and they impacted on trade, learning, social interaction and cultural diffusion - as well as resulting in periods of conflict with other powerful groups.

We may also think of the 'halberd bearers' culture as part of a larger superculture - recognised by Childe (1958) by their metalworking and use of riveted daggers. We may think of this superculture, dominated by MSY I2 DNA as interacting across Eurasia with another superculture, dominated by MSY R1 DNA. This superculture interaction can help us understand the pattern of archaeology in the traditional recognised archaeological cultures - across Europe into Asia, and from the middle-Neolithic and through to the complexities of the Atlantic Bronze Age.

But that simplified approach does not address the full story. There are many more DNA types involved both within, and outside, those two supercultures. The supercultures also have elements that merge – such as the I2a2 migrants - who had advanced astronomical knowledge, and built rondels - in an enclave within the R1superculture. They were absorbed to become an integral part of Yamnaya.

In essence, to understand our pre-history, we need to be able to view the people of Eurasia as a hyperculture - constantly evolving, interacting and sharing over millennia. The shared strands of

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DNA show us that as well as conflict - we all have a history/pre-history, of shared wisdom, understanding and positive social interactions.

We may find that certain archaeological phenomenon, such as constructing dolmen, may have been re-invented by different cultures with different DNA millennia and continents apart. However, we may also find that the strands of shared history and memory (Koch 2016) mean that on many occasions- it is not re-invention - but a visible expression of the millennia long DNA/memory threads that run across and through our hyperculture.

Today, the world wide web makes us more visibly one large community sharing knowledge, wisdom and understanding. It is perhaps, a modern expression of what has taken place for millennia, across continents - and is expressed in our archaeology/cultural heritage.

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Annex

Alternative Option for Map 3 Gimbutas wave 1

The main option in the core text proposed that the male people in Gimbutas wave 1 carried I2a2 and R1b pre-L23 DNA.

Changes to map 3 – wave1

This option considers a more controversial 'what if' scenario:

- that wave 1 carried R1b-L23 DNA; and,
- that L51 and L11 sub-clades were formed in the Carpathian Basin – Upper Tisza River.

Evidence - modern DNA and the R1b phylogenetic tree.

Studies of modern DNA are often overlooked in preference to studying aDNA results. However, understanding the phylogenetic tree and the distribution of Rib clades M269*, L23*, L51* and L11* (Myres 2010) is potentially informative about the movement of R1b into western Europe. The key points have been summarised here, and in short,

- the data can be interpreted to suggest that L51 formed in western Europe.
- analysis of the R1b phylogenetic shows (see methods section for links to the detail) a bottleneck between L51's formation about 4100 BCE and the sudden expansion of the U106 and P312 sub-clades after 2,800 BCE.

Point of origin for wave 1. Gimbutas proposed a movement from the Sredny Stog culture into the Carpathian Basin around 4500BCE – a date now thought to signal a change in the Dereivka area from the Mariupol culture to the Sredny Stog culture.

The alternative model for wave 1 could be:

- Around 4400 BCE R1b-L23 formed around the Dereivka area in the Mariupol/Sredny Stog 1 culture and migrated both east and west from there shortly afterwards.
- Autosomal Caucasian Hunter Gatherer (CHG) DNA arrived at Dereivka by 4200 BCE and was incorporated into the eastward migration but not into the migration that had already travelled west.
- The migration travelled quickly by horse. (Note: the dating of the domestication of horses in Dereivka is still controversial – see Anthony 2007 ch10).
- The migration to the east mixed to gain autosomal CHG. R1b-L23-Z2103 was formed and was later to become the dominant male line in the Yamnaya culture.
- The migration to the west reached the upper river Tisza and there R1b-L23-L51 was formed (without CHG).
- Evidence of the migration can be found in the presence of west Pontic copper daggers, gold spirals and pins, heavy hammer axes etc. in the Carpathian Basin - where these metalworking links were maintained from 4,500 BCE until 3,700 BCE (Heyd et al 2015).

Implications for wave 2 / 3 period

Between 3600 and 3000 BCE the Danube Valley was occupied by the I2a1 'riveted dagger' migration.

This model proposes that

- The R1b-L51and the newly formed L11 descendants, were cut off from their tanged dagger cousins in the Yamnaya culture and they were confined to a smaller role within the Baden culture.

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- The I2a1 reflux wave reached the Tisza River by 3000 BCE carrying Steppe traditions (and possibly language) and triggered an interplay between the R1b and I2 groups leading to the development of a shared proto-Beaker tradition.
- At this stage both groups have still not received any Steppe admixture.

Advantages of wave 1 alternative

Wave 1 CHG free L11 would help explain why:

- There is a low CHG R1b-L11 sample in France – I1388 with only 17% CHG. This would require very rapid 'washing out' of the CHG. Possible wider R1b-L11 outlier issue to resolve?
- Two Bronze Age Rib-P312 samples (MG104 and TV3831) have been identified in Iberia with little or no CHG component (Martiniano et al 2017) or trace CHG (Genetiker Blog). This would require complete or almost complete 'washing out' of the CHG autosomal component.

The final version of the Olalde et al 2017 paper may have new samples that support allow us to reject one (or both) of these alternatives.

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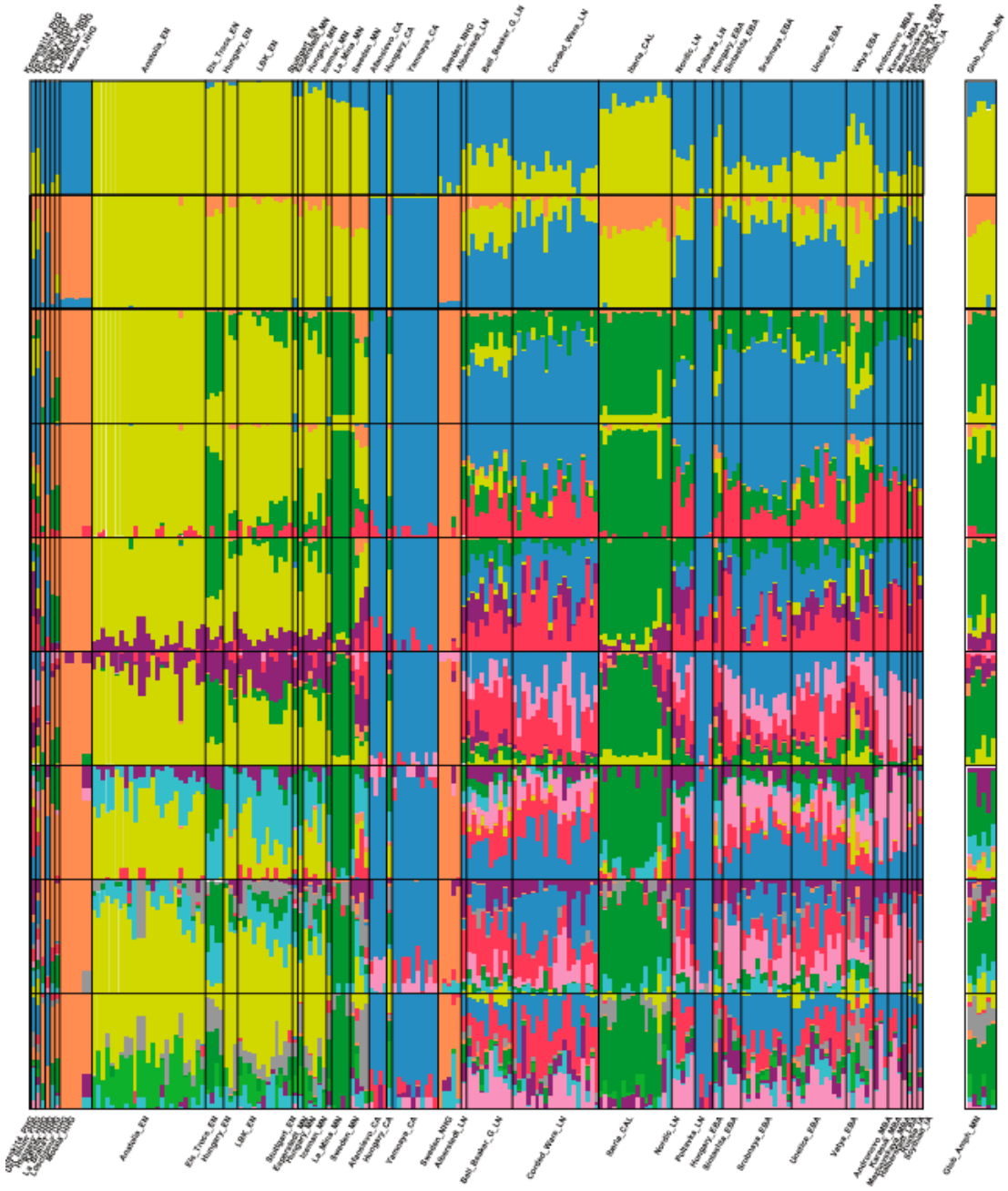
Admixture analysis based on ancient variation

Figure S7- Admixture analysis based only on ancient variation.



Ancestry proportions inferred from model-based clustering in the ancient individuals. Admixture plots for K=2 to K=10 (Related to fig 2B).The populations are plotted from left to the right according to the following order: Anatolia_EN, Ust_Ishim_PHG, Karasuk_MBA, Corded_Ware_LN, LBK_EN, Iberia_CAL, Motala_HHG, Srubnaya_EBA, Yamnaya_CA, Iceman_MN, Andronovo_MBA, Loschbour_HHG, Unetice_EBA, Stuttgart_EN, Bell_Beaker_G_LN, Afansievo_CA, Poltavka_LN, Nordic_LN, Alberstedt_LN, Els_Trocs_EN, La_Brana1_HHG, Kostenki14_PHG, La_Mina_MN, Karelia_HHG, Mezhovskaya_MBA, Sweden_NHG, Hungary_MN, Halberstadt_LBA, Scythian_IA, Vatya_EBA, Sintashta_EBA, Esperstedt_MN, Hungary_EN, Russia_IA, Hungary_EBA, Hungary_CA, Hungary_HHG, Sweden_MN. The GAC samples of this study are displayed in the last box on the right.

Figure 1: Ancient Admixture Analysis (Tassi et al 2017 Supp. Info Figure S7)