Pots, stones, bones and a grain. The recipe for a more nuanced view of Neolithisation in Great Britain, Jutland and Switzerland

Martin Hinz

## Introduction

In this article I would like to invite you to immerse yourself in the complexity of the Neolithic transition in northern Europe (Gron and Sørensen 2018; Bogucki and Bogucki 1988; Fischer and Kristiansen 2002; Rowley-Conwy 2011; Klassen 2004; A. W. R. Whittle 2007; Albert J. Ammerman and Ammerman 2003; Price 2000; Cummings 2009; Gkiasta et al. 2003; A. Whittle, Healy, and Bayliss 2011; Johansen 2006; Colledge and Conolly 2007; Sheridan 2010; Zvelebil 1986), with a specific focus on Jutland, Britain, and Switzerland, to shed light on the diverse pathways through which Neolithisation unfolded. Despite a hiatus from direct engagement with this field over the past five years, in this study I try to leverages my expertise in data aggregation and pattern identification to contribute to the discussion about the Neolithic transformations across these regions. Focusing on a comparative approach, this research contrasts recent publications based on ancient DNA (aDNA) to illustrate the diversity of agricultural transitions and to challenge the notion of a monolithic process of Neolithisation (Allentoft, Sikora, Refoyo-Martínez, et al. 2024). This is not to say that I question the driving force of migration in the establishment of a farming economy per se. However, I think that a more nuanced view is needed of how this was established in the individual regions, what role the indigenous hunter-gatherer population played in this, and what cultural appropriation processes were linked to the adoption of the economy in each case.

The Neolithic expansion, originally perceived as a rather homogeneous northwestward spread (A. J. Ammerman and Cavalli-Sforza 1971; Pinhasi, Fort, and Ammerman 2005), is now understood to have occurred in waves (Hervella et al. 2012; Silva and Vander Linden 2017; Bocquet-Appel et al. 2012; Brami and Zanotti 2015; Shennan 2009), with the Atlantic façade and Switzerland among the later recipients. This study questions the apparent homogeneity suggested by archaeological maps (Gronenborn and Horejs 2023), revealing the underlying complexities of Neolithic spread as influenced by migration, environmental factors, and the integration of existing lifestyles, conditions and populations.

Different empirical analysis and theoretical considerations reveals distinct trajectories of Neolithisation, for example Bettina Schulz Paulsson’s mappings of the spread of the megalithic phenomenon (Bettina Schulz Paulsson 2017; B. Schulz Paulsson 2019) and Martin Furholt’s theoretical model (Furholt 2020) of archaeological Communities of Practice. Based on this ideas, in the following I will distinguish between the components of the Neolithic package (cereals and food production, pottery, megaliths, and population). Through case studies from Great Britain, Denmark (Jutland), and Switzerland, this research identifies varying patterns of adoption and adaptation to Neolithic lifestyles. It discusses the implications of these findings for understanding the interactions between migrating Neolithic populations and resident Mesolithic groups, offering a more complex picture of Neolithisation that incorporates elements of both migration and cultural integration.

This study ultimately argues for a differentiated understanding of the Neolithic transition, where localized conditions, interactions between different communities, and the selective adoption of Neolithic practices played crucial roles. By comparing the evidence from Britain, Denmark, and Switzerland, the paper demonstrates that the process of Neolithisation was not uniform but varied significantly across different regions, influenced by both internal dynamics and external migrations.

## General Background

The diffusion of the Neolithic culture across Europe was a complex and heterogeneous process, characterized by its propagation in waves rather than a uniform north-westerly spread. This is particularly evident in the Atlantic façade, the primary region for the spread of megalithic phenomena, which represents the fourth and approximately final wave of Neolithic expansion. Switzerland, encapsulated by an already established Neolithic economy, witnessed the emergence of a distinct Neolithic culture with the advent of lakeside settlements around 4400 BCE. Contrary to the apparent homogeneity suggested by archaeological maps, this spread encompassed a variety of practices, including agriculture, although it was closely associated with the slow migration of farming populations from West Asia and the advent of ceramic usage. The phenomenon of megalithic burials, as detailed in Bettina Schulz Paulsson’s comprehensive mapping, suggests a potential reverse trend in movement, with temporal discrepancies observed in the alignment of megalithic burials and neolithisation across Great Britain, southern Scandinavia, and Switzerland.

|  |
| --- |
| Figure 1: Selected Communities of Practice involved in the transition to a neolithic lifestyle, conceptualised after Furholt (2020). |

In the third millennium BCE, the dissemination of Beaker cultures presents a notable parallel in the evolution of Neolithic societies, prompting an examination through the lens of Martin Furholt’s theoretical framework (Furholt 2020). This model elucidates the distinctions and commonalities within the cultural practices associated with the adoption of individualized burial customs. Furholt’s approach, grounded in the concept of communities of practice, delineates burial rituals, settlement patterns, and ceramic production as distinct spheres of cultural activity. These spheres allow for the participation of individuals across various contexts, thereby facilitating engagement in diverse networks and cultural phenomena (Furholt 2020, 5). This analytical perspective enables the disaggregation of the Neolithic cultural package into discrete components, specifically cereals and food production, pottery, megaliths, and population structure ([Figure 1](#fig-cop)). Such differentiation reveals the varying degrees of involvement by different actors within these domains. By applying Furholt’s model, this analysis bridges the gap between local agency and the cultural changes engendered by migration. Consequently, it affords a nuanced understanding of the contributions of the local Mesolithic population to the Neolithic transition, facilitating a probabilistic assessment of their involvement in these transformative processes.

The nuanced perspective on the transition to Neolithic ways of living, particularly in southern Scandinavia, aligns with earlier scholarly discussions. Zvelebil and Rowley-Conwy’s 1980s proposition of a phased transition (Zvelebil and Rowley-Conwy 1984), emphasizing the active engagement of local populations, contrasts with Rowley-Conwy’s subsequent shift towards acknowledging the significant role of migration in paralleling cultural and economic transformations (RowleyConwy 2004). This latter viewpoint gradually superseded the 1990s’ prevalent theory of indigenous adoption marked by gradual economic evolution. Advancements in ancient DNA (aDNA) analysis have increasingly substantiated migration as a pivotal explanatory model (Bramanti et al. 2009; Haak et al. 2005; Haak et al. 2010), seemingly diminishing the Mesolithic’s contribution to this transition (Gron, Sørensen, and Rowley-Conwy 2020). However, divergent perspectives persist, evidenced by discussions on an experimental phase in the shift towards agriculture, described by Graeber and Wengrow (2021) as “play farming.” The placement of this experimental phase relative to the transition depends on the interpretative lens and specific contextual factors. Neolithisation, understood not as a singular event but as a multifaceted process, is subject to variable manifestations contingent upon distinct circumstances. Accordingly, the interrelated components of the Neolithic cultural package suggest a propensity for mutual facilitation rather than obligatory co-dependence, thereby allowing for varied developmental pathways.

## Methods

To gain a comprehensive and nuanced understanding of processes in the individual study regions, the study dissected its components — cereals and food production, pottery, megaliths, and population growth — each examined independently. Literature provided the chronology for the advent of pottery and megalithic structures. The investigation of food production involved analyzing indicators of land cultivation and finds of cereal remains, alongside with a general population development analysis through the sum calibration of radiocarbon dates. Recognising that each of these indicators in itself is subject to error and is influenced by different distorting factors, each individual result must be viewed critically, and only the correlation between individual indicators can be taken as an indication of the development under investigation. Deviations between individual indicators require special consideration and explanation

The assessment of land cultivation was based on the analysis of herb versus tree and shrub pollen ratios, utilizing data from the Neotoma database (Williams et al. 2018). This process involved downloading data sets for specific geographic areas using the neotoma2 R package (Dominguez and Goring 2023) (only pollen data, only the pollen groups ‘UPHE’ and ‘TRSH’, only data with a chronology). The ratio of ‘UPHE’ to ‘TRSH’ was then calculated for each individual sample within the respective profiles. This was then averaged using a rolling window with a width of 100 years, and the proportion of ‘UPHE’ was then plotted in the diagram.

For the analysis of radiocarbon dating, both general and cereal-specific data were sourced from the open data infrastructure and database for chronometric data XRONOS (https://xronos.ch), using its dedicated R package. After filtering and deduplication, the rcarbon R package (Crema and Bevan 2021) was employed for analysis, adhering to its default settings. This involved site-level binning and smoothing the data with a 100-year rolling window. While the analysis tested theoretical growth models using default settings, these aspects were not central to the result interpretation. Each dataset was complemented with an interpretive framework (Panel IV), and the synthesized data for each region was then graphically presented.

## Great Britain

|  |
| --- |
| Figure 2: Data Analysis of the evidence from the UK. I) Running Mean (100 years) of Herb Pollen Percentage from 136 pollen profiles; II) Sum Calibration (SPD) from radiocarbon samples from cereals (n = 1613, sites = 461); III) Sum calibration (SPD) from all radiocarbon data, binned by site (n=19694 from 4580 sites); IV Interpretation and cultural developments. |

In the examination of Neolithisation across Great Britain, Alasdair Whittle and colleagues application of sequential calibration (A. Whittle, Healy, and Bayliss 2011) has meticulously delineated the timing and trajectory of this process, proposing a model consistent with rapid, migration-driven expansion. I have not sought to amend this analysis but rather to complement through the overarching evaluation of alternative indicators ([Figure 2](#fig-panel-uk)), utilizes aggregated pollen and radiocarbon date collections. For this, I synthesised pollen data from 136 individual profiles, focusing on the tree/shrub to herb pollen ratio. This condensed analysis reveals that the transition to Neolithic practices, marked by landscape clearing, becomes significantly evident only from the Bronze Age, suggesting minimal agricultural impact during the initial Neolithisation phase. Whilst the radiocarbon dates for cereals start to appear from around 3900 BCE, with a pronounced peak from 3700 BCE, there is little effect on the open land indicators in the form of herb pollen. A regionalised analysis with a stronger focus on the southern part of the United Kingdom could probably show a visible deflection, but is outside the scope of this paper. After this first peak, the intensity of the cereal signal drops significantly and remains at a very low level, almost disappearing completely from 3000 BCE onwards. It is not until 2500 BCE that the evidence of cereals in the radiocarbon record begins to increase again and to be steady, and it is not until 1500 BCE that significantly higher values are reached than in the Neolithic (taking into account the blurring effects caused by the summation of radiocarbon dates). However, from 3500 BCE onwards there is a noticeable opening of the land (albeit to a limited extent). The discrepancy between increased pollen values for herbs and decreasing values for cereal dating indicate that the land opening could not be primarily due to cereal production, but to other land use (pastoral?).

This is in line with earlier analysis from summed radiocarbon dates of cereal finds and there interpretation: Stevens and Fuller (2012) asked, whether ‘Neolithic farming [did] fail’, highlighting a pronounced boom and bust pattern and attributing the actual agricultural revolution to the Bronze Age. This fluctuation, corroborated by an expanded dataset from the XRONOS database, reflects broader trends in archaeological site prevalence, indicating economic volatility associated with the newly introduced agricultural practices. Stevens and Fuller (2012) attributed this reduction of agricultural activity to climate detoriation, but I wonder if the decline observed primarily in the second half of the 4th millennium may imply the unsustainability of the migrant economy. Supporting this migration hypothesis, the current analysis of the Allentoft paper (Allentoft, Sikora, Refoyo-Martínez, et al. 2024) indicates a substantial proportion of Anatolian DNA within the British Isles, akin to levels found in France, suggesting minimal influence from the local Mesolithic population on both the genetic makeup and lifestyle.

The contemporaneity of Carinated Bowls pottery with other Neolithic indicators further underscores the synchronicity of these cultural transitions. Whittle and colleagues (A. Whittle, Healy, and Bayliss 2011) comprehensive data compilation reveals a consistent south-north gradient in the spread of Neolithic practices across Britain, with little deviation in timing, suggesting a predominantly migration-driven process.

The summation of all radiocarbon dates combined shows that there is a significant increase in the number of radiocarbon dated sites from around 4000 BCE, with a markedly accelerated development from 3800 BCE (again, considering the smearing effects of radiocarbon summation). This is followed by a decline, a well-known boom-and-bust pattern already prominently documented elsewhere (Shennan et al. 2013), whereby the detectability and archaeological prominence of sites from this period (megalithic architecture) is also likely to play a role here. At the same time as the increase in dated cereal finds, there is a general increase in radiocarbon dated sites, which continues from around 2500 BCE into the Bronze Age.

Megaliths appear to have been an integral part of the package (B. Schulz Paulsson 2019) that was taking root on the island. The dating is only slightly offset from the first other signs of the new economy, way of life and perhaps ideology, so this piece of the puzzle provides further evidence that an already established and self-contained, integrated new way of life sought to settle in the British Isles, with little room for adaptation to local conditions, possibly contributing to the less than straightforward establishment.

Summarizing, the rapid dissemination of a fully-fledged Neolithic package, characterized by a pronounced economic boom and bust pattern and a relatively low (~10%) admixture rate, indicates limited interaction with, and influence from, the Mesolithic population post-4000 BCE. Evidence suggests a phase of contact and experimentation prior to 4000 BCE, yet this appears to have had minimal impact on subsequent developments, leading to the likely displacement or assimilation of the Mesolithic remnants. This narrative underscores the critical role of migration in shaping the Neolithic landscape of Britain, with minimal room for the Mesolithic population in the post-4000 BCE era.

## Jutland

|  |
| --- |
| Figure 3: Data Analysis of the evidence from the UK. For the explanation of the individual plots, please refer to [Figure 2](#fig-panel-uk). |

In examining the transition to Neolithic practices within the Jutland Peninsula and Denmark, recent DNA evidence has necessitated a reevaluation of the hunter-gatherer population’s role, with narratives shifting dramatically to suggest significant conflict, possibly even to the extent of genocide by agrarian immigrants, as proposed recently by Anders Fischer in a conference paper (less dramatic in (Allentoft, Sikora, Fischer, et al. 2024)). This stark reinterpretation highlights the complexities of integrating new genetic data into existing archaeological narratives. It can be anticipated that the results of recent excavations and findings will shed further light on this dynamic and perhaps lead to a slightly different perspective. The sites found near Syltholm (Groß and Rothstein 2023; Gron et al. 2024) in particular are likely to contribute to a greater focus on the processual nature of Neolithisation in southern Scandinavia and the possible long-term parallelism of different lifestyles and economic strategies.

The aggregated pollen data ([Figure 3](#fig-panel-dk)), sourced from the Neotoma database, offers a glimpse into the development of open land in Neolithic Jutland, albeit with a reliance on North German profiles due to the scarcity of Danish records in that database. This data suggests an slightly earlier and more sustainable appearance of Neolithic practices compared to Britain, with a definitive transition visible only by the late Bronze Age. A notable increase in herb pollen starts at (or shortly before) 4000 BCE, indicates initial agricultural activities, with a second pronounced increase after 3700 BCE, followed by reforestation and a significant landscape opening in the late Bronze Age.

The cereal dates are consistent with this timeline and show fluctuations in agricultural productivity, with a notable increase towards the Late Bronze Age that is not entirely dissimilar to the patterns observed in Britain. Here, too, we can see a boom-and-bust pattern, although the decline in the dated cereals is not as pronounced as in the UK, and this signal never fully disappears. It is perhaps not entirely unreasonable to assume that the early peak in dated cereals is also at least partly due to the research-focussed search for the earliest possible dates. However, the curve recovers, only to fall again from around 3000 BCE and remain at a low level until around 2200 BCE. This is the time of the Corded Ware, for which a pastoral-oriented economy can be made credible, but in any case the archaeological visibility of settlement sites declines significantly.

The archaeological site distribution does not exhibit the same boom-and-bust pattern seen in Britain throughout the Neolithic, suggesting a different trajectory of settlement and economic development, despite a high proportion of Anatolian DNA indicating significant migration. The highest peak of radiocarbon dated sites is at 3600 BCE, certainly influenced by dating of megalithic graves. As might be expected, the number of dates decreases towards and during the Corded Ware period and only increases again significantly from the Middle Bronze Age onwards.

Ceramics in Denmark predate Neolithisation by approximately 600—800 years, indicating an early familiarity with key Neolithic technologies among local populations, contrasting sharply with the British context. The comprehensive chronology of innovations compiled by Gron and Sørensen (Gron and Sørensen 2018) details the difficulties with the narrative of a sudden and sharp cultural change, showing that many hallmark Neolithic changes predate or follow the conventional threshold of 4000 BCE. This suggests a more gradual and stable integration of Neolithic practices, without the pronounced economic setbacks characteristic of Britain. The arrival of the Neolithic in the north was sudden and dramatic, certainly, but clearly the agents of the innovation were better prepared for the local conditions, and the overall integration of the lifestyle more sustainable and less disruptive.

The megalithic burial practice began with a clear delay to the first establishment of the Neolithic way of life (B. Schulz Paulsson 2019). Intermediate steps via earthen longbarrows towards a monumental, collective mode of burial, which ultimately demonstrated the impact of the ideology that also found its way into large parts of Europe, show that it did not come to the adoption of a complete, self-contained package of innovations, but to selective introduction — or adoption.

The evidence points to a more active role and greater compatibility of the Mesolithic populations with Neolithic newcomers in Denmark, as indicated by a higher degree of admixture (~20%) and a less tumultuous transition to agriculture. This scenario posits a likely retreat of Mesolithic communities into refugia, as seen in sites like Syltholm and Ostorf (Lübke, Lüth, and Terberger 2009; Fernandes et al. 2015), where aspects of their lifestyle and genetic signatures persist. In summary, the Jutlandic case study presents a model of Neolithisation marked by gradual integration, stable development, and significant interaction between Mesolithic and Neolithic populations, challenging the notion of a unilateral, conflict-driven transition.

## Switzerland

|  |
| --- |
| Figure 4: Data Analysis of the evidence from the Switzerland For the explanation of the individual plots, please refer to [Figure 2](#fig-panel-uk). |

In Switzerland, the transition from the Mesolithic to the Neolithic, particularly evident in lakeshore settlements (Hafner and Suter 2003), presents a stark contrast to earlier patterns, highlighting a nuanced process of Neolithisation that diverges significantly from the experiences in Jutland or Britain.

Notably, the Neolithic transition is marked by sparse signals at the scale of vegetation changes ([Figure 4](#fig-panel-ch)), with significant alterations occurring primarily in the Early Bronze Age. Early indications of cereal cultivation between 6500 and 4500 BCE suggest a period of agricultural experimentation (Nielsen 2003; Tinner, Nielsen, and Lotter 2007), albeit at a minimal level. A recent study on the direct dating of cereal remains in presumed Mesolithic contexts (Jacomet and Vandorpe 2022) came to the conclusion that all direct evidence of such agricultural activities dates later, i.e. that all dated cereal grains were dated to after 4500 BCE.

The Bronze Age heralds more definitive shifts in agricultural practices, as seen in herb pollen concentrations, yet the overall magnitude of change remains comparatively lower than in Jutland or Britain. Radiocarbon dating of cereals, constrained by the preference for dendrochronology in lakeshore settlement studies, supports the onset of cereal use around 4400 BCE, with no substantial evidence for earlier cultivation. Unfortunately, the data in XRONOS that can be directly linked to the dating of cereals is still insufficient, and the picture will certainly become much clearer in this respect over the next few years.

The straightforward evaluation of the sum calibration of all data from Swiss contexts is not inconclusive. The number of dated settlements increases rapidly after 4500 BCE, congruent with the establishment of the lakeshore Neolithic. A clear decline after 3700 can be linked to the general decline in settlement activity in the transition to the Horgen phase, which has been discussed elsewhere (Heitz, Laabs, et al. 2021; Heitz, Hinz, et al. 2021). However, the evaluation of radiocarbon dating must be carried out with caution, especially in Switzerland: Due to the dominance and accuracy of dendrochronological dating that can be carried out on lakeshore settlements, the validity of a summation calibration for this area is rather questionable.

|  |
| --- |
| Figure 5: Population estimation for the Swiss Plateau using a Bayesian Hierarchical Model. |

To overcome the dating challenges, a multiproxy method based on a Bayesian hierarchical model was developed (Hinz et al. 2024) that integrates different data streams to produce a more robust chronology of settlement and agricultural development to compensate for these weaknesses. The integration of radiocarbon and dendrochronological dates with aoristics and land opening ([Figure 5](#fig-popest-swiss-plateau)) shows a marked increase in the middle of the 5th millennium, then a plateau during the 4th millennium, evolving to a maximum at the turn of the Corded Ware style. Overall, colonisation seems to have taken place at a low but stable level. The genetic data here are not published and resolved in the same way as in the other study regions, especially for the earlier parts of the neolithic, due to the lack of burials and therefore human remains. But in the sites before the influx of Caucasian ancestry, the admixture is significantly greater than in the areas before, up to 30% on average across the sites (Furtwängler et al. 2020). The so-called Western hunter-gatherers thus play a much greater role in the population of Neolithic Switzerland.

Pottery, while present in the periphery, only becomes prevalent with the advent of lakeshore Neolithic settlement from 4400 BCE (Ebersbach et al. 2012), suggesting a delayed but comprehensive adoption of Neolithic practices.

Megalithic burial pratices were never established in Switzerland in the same way as in the other regions analysed. There is a sub-megalithic predecessor, the so-called Chamblandes graves, which were assumed to be burials of the inhabitants of the lakeshore Neolithic. However, more recent extensive dating (Steuri et al. 2023) shows that these burials cannot be parallelised with the settlement of the lakeshore. In addition, they are geographically limited to a southern area and cannot be said to have been adopted throughout the Swiss Plateau. Other, later megalithic burials do exist in Switzerland, but are very rare compared to the regions analysed so far (Ramstein et al. 2022). The use of dolmens and other comparable monuments takes place here over long periods of time, but at a comparably extremely low frequency. If we take the archaeological record seriously as it is, then we could speak of a “play burial” in reference to Graeber and Wengrow’s “play farming”. Apart from that, this burial custom, and therefore the ideology behind it, obviously played no role in the Neolithic of Switzerland. This is also supported by the clearly different settlement pattern, as far as the archaeological record currently indicates, and the fact that this settlement pattern (and possibly also the economic pattern associated with it) is not clearly influenced by the transition to the Corded Ware period, as is the case in other parts of Europe.

This pattern implies a gradual, selective shift. The switch to a new lifestyle took place suddenly in historical terms. But only ceramics and economy found its way into the Swiss Neolithic, and there is a lack of pronounced boom-and-bust cycles observed elsewhere. The integration of Mesolithic populations into the new Neolithic environment, characterized by the higher admixture, might have played a role here.

Comparatively, the Swiss situation shares similarities with southern Scandinavia in the peripheral availability of arable farming techniques, yet diverges from the British scenario by avoiding extreme economic fluctuations and demonstrating a higher degree of genetic diversity. This unique blend of factors suggests a localized and highly adapted approach to Neolithisation in Switzerland, distinct from its European counterparts, making a significant Mesolithic influence and a nuanced, stable transition to agricultural societies possible.

## Summary

The process of Neolithisation across Europe exhibits diverse trajectories, characterized by variations in pace, scale, and the elements involved in the transition to agricultural lifestyles. In the case of Great Britain, the scenario closely mirrors Anders Fischer’s depiction of a nearly complete population replacement, suggesting migration as the primary, if not exclusive, mechanism driving Neolithisation. Conversely, on the Jutland Peninsula, such a drastic exchange appears far less probable. Here, the presence of prosperous coastal Mesolithic communities, already well-acquainted with Neolithic innovations, points towards a smoother integration of these advancements, highlighting a higher degree of compatibility between the two ways of life. And, after a longer transitional period with parallel lifeworlds, in which the hunter-gatherer lifestyle retreated more and more into Refugia over 700 years, the Neolithic was finally established before it was transformed once more by the Corded Ware.

Switzerland presents a unique case where the inception of Neolithic practices is indeed tied to migration, but only after a considerable delay, and with a significant contribution from individuals of Western Hunter-Gatherer heritage. This interaction fostered a distinct and stable Neolithic culture that seamlessly transitioned into the Bronze Age with only minor modifications in settlement patterns. This scenario suggests a more deliberate and involved role for Hunter-Gatherer communities in the adoption of Neolithic practices, despite potential gaps in the archaeological record. In all cases, new arrivals with new genetic signatures were instrumental in reorganising the way of life. In some cases, they brought with them a complete package of innovations. In others, these innovations were already known (e.g. ceramics), or were accessible in the periphery without gaining a foothold. Here, the newcomers played the role of the ultimate triggers that helped the innovations to break through. In yet other cases, certain elements of the new way of life were not adopted at all, whether as an adaptation to local conditions or due to the fact that the original inhabitants of these regions played a greater role in the acceptance of the new way of life. These different aspects linked different communities of practice in different ways, connecting them on one level but making a difference in other aspects. Collectively, these variations underscore the complexity of the Neolithisation process, revealing a spectrum of human responses to the challenges and opportunities of early agricultural life across different European landscapes.

## Acknowledgment

Data were obtained from the Neotoma Paleoecology Database (<http://www.neotomadb.org)> and its constituent databases. The work of data contributors, data stewards, and the Neotoma community is gratefully acknowledged.

## References

Allentoft, Morten E., Martin Sikora, Anders Fischer, Karl-Göran Sjögren, Andrés Ingason, Ruairidh Macleod, Anders Rosengren, et al. 2024. “100 Ancient Genomes Show Repeated Population Turnovers in Neolithic Denmark.” *Nature* 625 (7994): 329–37. <https://doi.org/10.1038/s41586-023-06862-3>.

Allentoft, Morten E., Martin Sikora, Alba Refoyo-Martínez, Evan K. Irving-Pease, Anders Fischer, William Barrie, Andrés Ingason, et al. 2024. “Population Genomics of Post-Glacial Western Eurasia.” *Nature* 625 (7994): 301–11. <https://doi.org/10.1038/s41586-023-06865-0>.

Ammerman, A. J., and L. L. Cavalli-Sforza. 1971. “Measuring the Rate of Spread of Early Farming in Europe.” *Man* 6 (4): 674–88. <https://doi.org/10.2307/2799190>.

Ammerman, Albert J., and Albert J. archéologue Ammerman. 2003. *The widening harvest: the Neolithic transition in Europe : looking back, looking forward*. Colloquia and conference papers 6. Boston Mass: Archaeological Institute of America.

Bocquet-Appel, Jean-Pierre, Stephan Naji, Marc Vander Linden, and Janusz Kozlowski. 2012. “Understanding the Rates of Expansion of the Farming System in Europe.” *Journal of Archaeological Science* 39 (2): 531–46. <https://doi.org/10.1016/j.jas.2011.10.010>.

Bogucki, Peter I., and Peter I. 19-Bogucki. 1988. *Forest farmers and stockherders: early agriculture and its consequences in North-Central Europe*. First published 1988 / this digitally printed version 2009. New studies in archaeology. Cambridge: University Press.

Bramanti, B., M. G. Thomas, W. Haak, M. Unterlaender, P. Jores, K. Tambets, I. Antanaitis-Jacobs, et al. 2009. “Genetic Discontinuity Between Local Hunter-Gatherers and Central Europe’s First Farmers.” *Science* 326 (5949): 137–40. <https://doi.org/10.1126/science.1176869>.

Brami, Maxime, and Andrea Zanotti. 2015. “Modelling the Initial Expansion of the Neolithic Out of Anatolia.” *Documenta Praehistorica* 42 (December): 103–16. <https://doi.org/10.4312/dp.42.6>.

Colledge, Sue, and James Conolly, eds. 2007. *The origins and spread of domestic plants in Southwest Asia and Europe*. Walnut Creek (Calif.): Left coast press University college London institute of archaeology publ.

Crema, Enrico R., and Andrew Bevan. 2021. “Inference from Large Sets of Radiocarbon Dates: Software and Methods.” *Radiocarbon* 63 (1): 23–39. <https://doi.org/10.1017/RDC.2020.95>.

Cummings, Vicki. 2009. *A view from the West: the neolithic of the Irish sea zone*. Oxford: Oxbow books.

Dominguez, Socorro, and Simon Goring. 2023. *Neotoma2: An r Package to Access Data from the Neotoma Paleoecology Database*. Zenodo. <https://doi.org/10.5281/zenodo.10198238>.

Ebersbach, Renate, Marlu Kühn, Barbara Stopp, and Jörg Schibler. 2012. “Die Nutzung neuer Lebensräume in der Schweiz und angrenzenden Gebieten im 5. Jahrtausend vor Christus.” *Jahrbuch Archäologie Schweiz* 95: 7–34. <https://doi.org/10.5169/seals-392483>.

Fernandes, Ricardo, Pieter Grootes, Marie-Josée Nadeau, and Olaf Nehlich. 2015. “Quantitative Diet Reconstruction of a Neolithic Population Using a Bayesian Mixing Model (FRUITS): The Case Study of Ostorf (Germany).” *American Journal of Physical Anthropology* 158 (2): 325–40. <https://doi.org/10.1002/ajpa.22788>.

Fischer, Anders, and Kristian Kristiansen, eds. 2002. *The neolithisation of Denmark: 150 years of debate*. Sheffield archaeological monographs 12. Sheffield: J.R. Collis.

Furholt, Martin. 2020. “Social Worlds and Communities of Practice: A Polythetic Culture Model for 3rd Millennium BC Europe in the Light of Current Migration Debates.” *Préhistoires Méditerranéennes*, no. 8 (January). <https://doi.org/10.4000/pm.2383>.

Furtwängler, Anja, A. B. Rohrlach, Thiseas C. Lamnidis, Luka Papac, Gunnar U. Neumann, Inga Siebke, Ella Reiter, et al. 2020. “Ancient Genomes Reveal Social and Genetic Structure of Late Neolithic Switzerland.” *Nature Communications* 11 (1): 1915. <https://doi.org/10.1038/s41467-020-15560-x>.

Gkiasta, Marina, Thembi Russell, Stephen Shennan, and James Steele. 2003. “Neolithic Transition in Europe: The Radiocarbon Record Revisited.” *Antiquity* 77 (295): 45–62. <https://doi.org/10.1017/S0003598X00061330>.

Graeber, David, and D. Wengrow. 2021. *The Dawn of Everything: A New History of Humanity*. First American edition. New York: Farrar, Straus; Giroux.

Gron, Kurt J., Darren R. Gröcke, Daniel Groß, Peter Rowley-Conwy, Harry K. Robson, and Janet Montgomery. 2024. “Neolithisation Through Bone: Stable Isotope Analysis of Human and Faunal Remains from Syltholm II, Lolland, Denmark.” *Journal of Archaeological Science: Reports* 53 (February): 104384. <https://doi.org/10.1016/j.jasrep.2024.104384>.

Gron, Kurt J., and Lasse Sørensen. 2018. “Cultural and Economic Negotiation: A New Perspective on the Neolithic Transition of Southern Scandinavia.” *Antiquity* 92 (364): 958–74. <https://doi.org/10.15184/aqy.2018.71>.

Gron, Kurt J., Lasse Sørensen, and Peter Rowley-Conwy. 2020. “Introduction.: Agricultural Origins: Where Next?” In, edited by Kurt J. Gron, Lasse Sørensen, and Peter Rowley-Conwy, 1–6. Oxbow Books. <https://doi.org/10.2307/j.ctv13gvh1g>.

Gronenborn, Detlef, and Barbara Horejs. 2023. “Expansion of Farming in Western Eurasia, 9600 - 4000 Cal BC (Update Vers. 2023.1),” October. <https://doi.org/10.5281/ZENODO.10047818>.

Groß, Daniel, and Mikael Rothstein, eds. 2023. *Changing identity in a changing world: current studies on the Stone Age around 4000 BCE*. Leiden: Sidestone Press.

Haak, Wolfgang, Oleg Balanovsky, Juan J. Sanchez, Sergey Koshel, Valery Zaporozhchenko, Christina J. Adler, Clio S. I. Der Sarkissian, et al. 2010. “Ancient DNA from European Early Neolithic Farmers Reveals Their Near Eastern Affinities.” *PLOS Biology* 8 (11): e1000536. <https://doi.org/10.1371/journal.pbio.1000536>.

Haak, Wolfgang, Peter Forster, Barbara Bramanti, Shuichi Matsumura, Guido Brandt, Marc Tänzer, Richard Villems, et al. 2005. “Ancient DNA from the First European Farmers in 7500-Year-Old Neolithic Sites.” *Science* 310 (5750): 1016–18. <https://doi.org/10.1126/science.1118725>.

Hafner, Albert, and Peter J. Suter. 2003. “Das Neolithikum in der Schweiz.” *Journal of Neolithic Archaeology*, 5. <https://doi.org/10.12766/JNA.2003.4>.

Heitz, Caroline, Martin Hinz, Julian Laabs, and Albert Hafner. 2021. “Mobility as resilience capacity in northern Alpine Neolithic settlement communities,” June. <https://www.repository.cam.ac.uk/handle/1810/331590>.

Heitz, Caroline, Julian Laabs, Martin Hinz, and Albert Hafner. 2021. “Collapse and Resilience in Prehistoric Archaeology: Questioning Concepts and Causalities in Models of Climate-Induced Societal Transformations.” In, edited by Paul Erdkamp, Joseph G. Manning, and Koenraad Verboven, 127–99. Palgrave Studies in Ancient Economies. Cham: Springer International Publishing. <https://doi.org/10.1007/978-3-030-81103-7_5>.

Hervella, Montserrat, Neskuts Izagirre, Santos Alonso, Rosa Fregel, Antonio Alonso, Vicente M. Cabrera, and Concepción de la Rúa. 2012. “Ancient DNA from Hunter-Gatherer and Farmer Groups from Northern Spain Supports a Random Dispersion Model for the Neolithic Expansion into Europe.” *PLOS ONE* 7 (4): e34417. <https://doi.org/10.1371/journal.pone.0034417>.

Hinz, Martin, Joe Roe, Julian Laabs, Caroline Heitz, and Jan Kolář. 2024. “Bayesian Inference of Prehistoric Population Dynamics from Multiple Proxies: A Case Study from the North of the Swiss Alps,” February. <https://doi.org/10.31235/osf.io/dbcag>.

Jacomet, Stefanie, and Patricia Vandorpe. 2022. “The Search for a Needle in a Haystack New Studies on Plant Use During the Mesolithic in Southwest Central Europe.” *Journal of Archaeological Science: Reports* 41 (February): 103308. <https://doi.org/10.1016/j.jasrep.2021.103308>.

Johansen, Kasper Lambert. 2006. “Settlement and Land Use at the Mesolithic-Neolithic Transition in Southern Scandinavia.” *Journal of Danish Archaeology* 14 (June): 201–24. <https://doi.org/10.1080/0108464X.2006.10590118>.

Klassen, Lutz. 2004. *Jade und Kupfer: Untersuchungen zum Neolithisierungsprozess im westlichen Ostseeraum unter besonderer Berücksichtigung der Kulturentwicklung Europas 5500-3500 BC*. Jutland Archaeological Society Vol. 47. Moesgård: Jutland Archaeological Society etc.

Lübke, Harald, Friedrich Lüth, and Thomas Terberger. 2009. “Fishers or Farmers? The Archaeology of the Ostorf Cemetery and Related Neolithic Finds in the Light of New Data.” *Berichte Der Römisch-Germanischen Kommission* 88: 30738.

Nielsen, Ebbe H. 2003. “Das Spätmesolithikum und die Neolithisierung in der Schweiz.” *Archäologische Informationen* 26 (2): 275–97. <https://doi.org/10.11588/ai.2003.2.12693>.

Pinhasi, Ron, Joaquim Fort, and Albert J. Ammerman. 2005. “Tracing the Origin and Spread of Agriculture in Europe.” *PLOS Biology* 3 (12): e410. <https://doi.org/10.1371/journal.pbio.0030410>.

Price, Theron Douglas, ed. 2000. *Europe’s first farmers*. Cambridge [etc: Cambridge University Press.

Ramstein, Marianne, Noah Steuri, David Brönnimann, Philippe Rentzel, Marcel Cornelissen, Dirk Schimmelpfennig, Flavio S. Anselmetti, et al. 2022. “The Well-Preserved Late Neolithic Dolmen Burial of Oberbipp, Switzerland. Construction, Use, and Post-Depositional Processes.” *Journal of Archaeological Science: Reports* 42 (April): 103397. <https://doi.org/10.1016/j.jasrep.2022.103397>.

Rowley-Conwy, Peter. 2011. “Westward Ho!: The Spread of Agriculture from Central Europe to the Atlantic.” *Current Anthropology* 52 (S4): S431–51. <https://doi.org/10.1086/658368>.

RowleyConwy, Peter. 2004. “How the West Was Lost: A Reconsideration of Agricultural Origins in Britain, Ireland, and Southern Scandinavia.” *Current Anthropology* 45 (S4): S83–113. <https://doi.org/10.1086/422083>.

Schulz Paulsson, B. 2019. “Radiocarbon Dates and Bayesian Modeling Support Maritime Diffusion Model for Megaliths in Europe.” *Proceedings of the National Academy of Sciences* 116 (9): 3460–65. <https://doi.org/10.1073/pnas.1813268116>.

Schulz Paulsson, Bettina. 2017. *Time and Stone: The Emergence and Development of Megaliths and Megalithic Societies in Europe*. Archaeopress Publishing Ltd. <https://doi.org/10.2307/j.ctv1pdrqjd>.

Shennan, Stephen. 2009. “Evolutionary Demography and the Population History of the European Early Neolithic.” *Human Biology* 81 (2/3): 339–55. <https://www.jstor.org/stable/41466605>.

Shennan, Stephen, Sean S. Downey, Adrian Timpson, Kevan Edinborough, Sue Colledge, Tim Kerig, Katie Manning, and Mark G. Thomas. 2013. “Regional Population Collapse Followed Initial Agriculture Booms in Mid-Holocene Europe.” *Nature Communications* 4 (October): 2486. <https://doi.org/10.1038/ncomms3486>.

Sheridan, Alison. 2010. “The Neolithization of Britain and Ireland: The ‘Big Picture’.” In, edited by Bill Finlayson and Graeme Warren, 89–105. Council for British Research in the Levant (CBRL). <https://www.jstor.org/stable/j.ctv307fh1r.14>.

Silva, Fabio, and Marc Vander Linden. 2017. “Amplitude of Travelling Front as Inferred from 14C Predicts Levels of Genetic Admixture Among European Early Farmers.” *Scientific Reports* 7 (1): 11985. <https://doi.org/10.1038/s41598-017-12318-2>.

Steuri, Noah, Marco Milella, Francesca Martinet, Luca Raiteri, Sönke Szidat, Sandra Lösch, and Albert Hafner. 2023. “First Radiocarbon Dating of Neolithic Stone Cist Graves from the Aosta Valley (Italy): Insights Into the Chronology and Burial Rites of the Western Alpine Region.” *Radiocarbon* 65 (2): 521–38. <https://doi.org/10.1017/RDC.2023.12>.

Stevens, Chris J., and Dorian Q. Fuller. 2012. “Did Neolithic Farming Fail? The Case for a Bronze Age Agricultural Revolution in the British Isles.” *Antiquity* 86 (333): 707–22. <https://doi.org/10.1017/S0003598X00047864>.

Tinner, Willy, Ebbe H. Nielsen, and André F. Lotter. 2007. “Mesolithic Agriculture in Switzerland? A Critical Review of the Evidence.” *Quaternary Science Reviews* 26 (9): 1416–31. <https://doi.org/10.1016/j.quascirev.2007.02.012>.

Whittle, Alasdair W. R. 2007. *Going over: the Mesolithic-Neolithic transition in north-west Europe*. Proceedings of the British Academy 144. Oxford: University Press.

Whittle, Alasdair, Frances Healy, and Alex Bayliss. 2011. *Gathering Time: Dating the Early Neolithic Enclosures of Southern Britain and Ireland, Volumes 1 and 2*. Oxbow Books. <https://doi.org/10.2307/j.ctvh1dwp2>.

Williams, John W., Eric C. Grimm, Jessica L. Blois, Donald F. Charles, Edward B. Davis, Simon J. Goring, Russell W. Graham, et al. 2018. “The Neotoma Paleoecology Database, a Multiproxy, International, Community-Curated Data Resource.” *Quaternary Research* 89 (1): 156–77. <https://doi.org/10.1017/qua.2017.105>.

Zvelebil, Marek, ed. 1986. *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and Their Transition to Farming*. New Directions in Archaeology. Cambridge [Cambridgeshire] ; New York: Cambridge University Press.

Zvelebil, Marek, and Peter Rowley-Conwy. 1984. “Transition to Farming in Northern Europe: A Hunter-Gatherer Perspective.” *Norwegian Archaeological Review* 17 (2): 104–28. <https://doi.org/10.1080/00293652.1984.9965402>.