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David J. Meltzer
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OVERTURE

It was the final, major act in the settlement of the earth. As we envision it, sometime before ~15,000 years ago a band of hunter-gatherers arrived in the region of what is now the Bering Sea, but was then a dry, largely grassy plain. Without realizing they were leaving one hemisphere for another, they slipped across the unmarked border separating Asia from America. From there they moved south, skirting past vast glaciers, and one day found themselves in a warmer, greener, and infinitely trackless land no human had ever seen before. It was a world rich in plants and animals that became ever more exotic as they moved south, but also a world growing poorer as dozens of great beasts lumbered past on their way to extinction. It was a world still shivering itself out of the coldest depths of an Ice Age. In this truly new world, massive ice sheets extended to the far horizons, the Great Lakes had not yet been born, and the ancestral Great Salt Lake was about to die.

They made history, those latter-day Asians, who by changing continents became the first Americans. Theirs was a dispersal the likes and scale of which was virtually unique in the lifetime of our species, and one never to be repeated. But they were surely unaware of what they had achieved, at least initially: Alaska looked little different from their Northeast Asian homeland, and there were hardly any barriers separating the two. Even so, that relatively unassuming move to the east, and the turn to the south that followed, was one of greatest journeys undertaken by ancient peoples in the distant past. Those first Americans could little imagine our intense interest in their accomplishment thousands of years later, and would almost certainly be puzzled – if not bemused – at how seemingly inconsequential details of their coming sparked a wide-ranging, bitter,

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and long-playing controversy, entangling archaeologists and anthropologists, geologist, linguists, paleontologists, and, especially of late, geneticists.

Here are the bare and (mostly) noncontroversial facts of the case. The first Americans came during the latter part of the Pleistocene or Ice Age, a time when the earth appeared vastly different than it does today. Tilts and wobbles in the earth's spin, axis, and orbit had altered the amount of incoming solar radiation, cooling northern hemisphere climates and triggering cycles of worldwide glacial growth. Two immense ice sheets, the Laurentide and Cordilleran, expanded to blanket Canada – reaching over 3 kilometers in thickness in places – and flow into the northern United States.

The rain and snow that fed the rise of these vast ice sheets, now frozen on land, failed to return to the oceans, causing global sea levels to fall, ultimately to ~134 meters below their present level.[1] The lower sea level exposed shallow continental shelf, including that beneath the Bering Sea, thereby forming a land bridge – known as *Beringia* – that linked Asia to America (today separated by ~90 kilometers of cold and rough Arctic waters) (Figure 1.1). That made it possible to walk from Siberia to Alaska. Of course, once people made it to Alaska, those same glaciers presented a formidable barrier to movement further south – depending, that is, on precisely when they arrived in this far corner of the continent.

The ice sheets changed climate and environment in still more profound ways. It was colder, of course, during the Ice Age. But the ice sheets rose so high they altered the movement of air masses, creating the paradox of Ice Age winters that in places were no colder and possibly even warmer than those of the present. The jet stream, displaced southward, brought rainfall and freshwater lakes to what is now western desert and plains, while today's Great Lakes were mere soft spots in bedrock beneath millions of tons of glacial ice grinding slowly overhead.

A whole zoo of giant mammals (*megafauna*, we call them) soon to become extinct, roamed this land. There were multiton proboscideans (mammoth, mastodon, and gomphothere), ground sloths taller than giraffes, camels, horses, and two dozen more herbivores including the glyptodont, a slow-moving mammal encased in a turtle-like shell and bearing an uncanny resemblance to a 1966 Volkswagen Beetle – or at least a submersible VW with an armored tail. Feeding on these herbivores was a gang of formidable predators: huge lions, saber-toothed cats, and giant bears. These now-vanished animals browsed, grazed, or hunted in richly mixed ecological communities.

But this was no fixed stage: from the frigid depth of the Late Pleistocene ~21,000 years ago – the Last Glacial Maximum (LGM) it's called – until its end ~11,700 years ago, the climate, environment, landscapes, and surrounding seascapes of North America were changing. Humans were present for some or all of that time (the jury is still out on this issue), but of one thing we are certain: it was a world unlike any experienced by people ever since.

Figure 1.1
Map of the western hemisphere, showing the extent of glacial ice at the Last Glacial Maximum 18,000 years ago, the approximate position of the coastline at the time, and some of the key early sites, archaeological and otherwise, hemisphere-wide. (David J. Meltzer.)

Once they got to America, the first people and their descendants lived in utter isolation from their distant kin scattered across the planet. Over the following millennia, agriculture was invented, human populations grew to the millions, and across the world great cities and powerful empires rose and fell. Yet, no human on either side of the Atlantic or Pacific oceans was aware of the others' existence.

It was not until Europeans sailed west across the Atlantic that the global circuit of humanity was complete. Peoples distantly related but long separated first encountered one another in a remote corner of northeast Canada around 1000 CE.[2] That initial contact between Norse Vikings and Native Americans was brief, often violent, and mostly served to thwart the Vikings' dreams of expansion and conquest, and drive them back to Greenland and Iceland. That brief encounter had none of the profound, long-term consequences that followed Columbus' splashing ashore on a Caribbean island that October day of 1492.

Fifteenth-century Europeans were profoundly puzzled by what they soon realized was far more than a series of islands, but instead a continent and peoples about whom the Bible, their principal source for earth and human history, said absolutely nothing. We can presume America's Indigenous peoples were just as perplexed by Europeans, but their initial reactions went unrecorded. Over the next several centuries, Europeans sought to ascertain who the "Indians" were, where they had come from, when they had arrived, and by what route. The idea they must be related to some historically known group, such as the Lost Tribes of Israel, held sway until the mid-19th century, when it became clear that wherever their origins, they had arrived well before any historically recorded moment. Ascertaining when would have to be found in the artifacts, bones, and sites left behind from a far more ancient time.

How ancient proved a matter of much dispute. It was only in 1927, and after centuries of speculation and more than fifty years of intense debate, that a discovery at the Folsom site in New Mexico finally demonstrated that the first Americans had arrived at least by late Ice Age times. The smoking gun? A distinctive, *fluted* spear point (one with a groove or channel on its face) found between the ribs of an extinct Pleistocene bison (Plate I). A hunter had killed that Ice Age beast when it was alive. A half-dozen years later – outside the town of Clovis, New Mexico – larger, less finely made, and apparently still older fluted spear points (Figure 1.2) than those at Folsom were found – this time with the skeletal remains of mammoth. *Paleoindians*, these early peoples were named, to recognize their great antiquity and their ancestry to American Indians.

A more precise measure of their antiquity came with chemist Willard Libby's Nobel Prize-winning development of radiocarbon (^{14}C) dating in the 1950s (Sidebar). By the early 1960s, that technique showed the Clovis occupation dated to almost 11,500 ^{14}C years before the present (BP) (that's ~13,350 *calibrated* years BP – I explain the distinction between radiocarbon and calibrated years in the Sidebar), with Folsom following several centuries later.

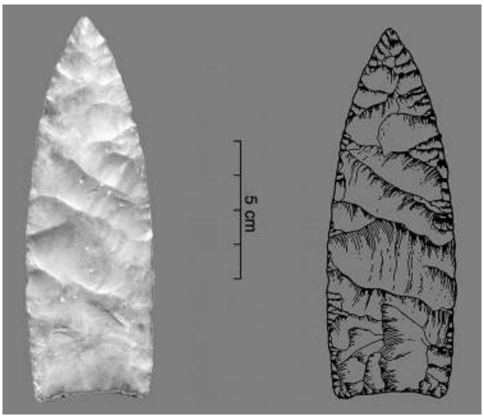

Figure 1.2
Clovis point from the Clovis site in New Mexico, displaying the type's diagnostic features, including fluting and outre passé (overshot) flaking. This particular specimen is made of Edwards Formation chert, probably from an outcrop source near Big Springs, Texas, ~300 kilometers southeast of the site. It was found near the vertebra and ribs of a mammoth. (Photograph by David J. Meltzer; line drawing by Frederic Sellet; arranged by Judith Cooper).

These radiocarbon ages bolstered the suspicion that Clovis people were the very first Americans, for the ages coincided beautifully with the retreat of North America's enormous continental glaciers which, it was widely believed, had long walled off travel to the south and forced any would-be first Americans to cool their heels in Alaska. But as the ice sheets retreated an "ice-free corridor," running roughly along the eastern flank of the Rockies, opened between them.

The passageway to unglaciated lower latitudes beckoning, the first Americans ostensibly charged through, then radiated across the length and breadth of North America with apparently breathtaking speed. Within a matter of centuries, Clovis and Clovis-like artifacts were spread across North America. Nor did they stop at the border: their descendants evidently continued racing south, arriving in Tierra del Fuego ~1,000 years after leaving Alaska (having developed en route artifacts that were no longer recognizably Clovis). It's an astonishing act of dispersal, especially given that it took our species more than 100,000 years just to reach the western edge of Beringia.

The possibility that Clovis groups dispersed throughout North America in what may have been just centuries is all the more striking given they were traversing an unfamiliar, ecologically diverse, and changing landscape. Yet they seemingly handled the adaptive challenges that posed with ease. Their toolkit, including its signature fluted points, is remarkably uniform across the continent. That uniformity is taken as further testimony to the speed of their dispersal: it happened so quickly there was hardly time for new point types or other tools to emerge.

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Sidebar: On Dates and Dating

Ages of objects and events can be estimated using a variety of methods that exploit nature's metronomes, which can beat at different measures and enable us to determine ages on a scale from centuries to billions of years. Some are based on the radioactive decay of elemental isotopes, such as radiocarbon (^{14}C), argon, and uranium. Others rely on incremental time markers such as dendrochronology, which derives ages from the annual growth rings in trees; or cumulative processes such as luminescence dating, which measures the build-up of electrons in crystal lattices within quartz grains; or changes in the position of the earth's magnetic pole (paleomagnetism). For a dating technique to be useful, the "beat" must be relatively constant over time; there must be a means of calibrating it in years; its rate of change has to match the time span of interest (short-lived isotopes that disappear in minutes will be useless in dating a sample thousands of years old); and, there has to be a means of linking the *sample* being dated, be it charcoal, quartz grains, or magnetized clay, to the *event* of interest, such as the occupation of an archaeological site.

How precise we can (or need to) be with those ages depends partly on the resolution of the technique, but also on what we are trying to date. If it's a process that unfolded over thousands of years, such as the onset of Pleistocene glaciation, approximate ages suffice (~2.5 million years, in this case). But if we seek to know when something happened in a narrower span, such as the centuries within which the ice-free corridor opened, or an even more specific moment in time, such as the occupation of an archaeological site, we need methods that give us the necessary chronological resolution.

Several dating methods are used in studying the peopling of the Americas, but radiocarbon dating is our chronological workhorse. It works off a straightforward decay principle (Figure 1.3): when cosmic ray neutrons bombard the earth's upper atmosphere, they react with nitrogen (^{14}N) to drive off a proton to form radioactive carbon or radiocarbon (^{14}C), one of several isotopes (*isotope* = same element but different mass) of carbon. Radiocarbon has the same chemical structure as elemental carbon (^{12}C), but a heavier mass (maintaining nitrogen's atomic mass of 14). Like ^{12}C, radiocarbon combines with oxygen to form carbon dioxide (CO_2), which is then absorbed by plants via photosynthesis, and moves up the food chain into the animals that feed on those plants.

When an organism dies, its supply of ^{14}C is no longer being replenished, and the resident ^{14}C begins to revert back to ^{14}N, and in this decay process releases a radioactive emission (beta particle). Immediately after death, ^{14}C decay produces roughly 15 beta emissions/gram/minute. After 5,730 years, half of the ^{14}C is gone, so the decay process yields only 7.5 beta emissions/gram/minute. That lapsed period is called a *half-life*. After another 5,730 years have passed (that is, 11,460 years after the organism died) another half of the original ^{14}C is now gone (we are down to 25 percent remaining), and the decay process yields roughly 3.75 beta emissions/gm/minute. And so on.

Thus, by measuring the amount of radiocarbon still present in a sample, one can calculate when the organism died. By consensus, all radiocarbon ages are expressed as years before present (BP), "present" being arbitrarily set at 1950, the year the first successful dates were reported by Willard Libby. We set our radiocarbon clocks to 1950 to avoid the confusion that would follow when comparing the ages of samples whose radioactivity was measured at different times (e.g. in 1988, as opposed to 2018).

Radioactivity is a statistically random process. When it's measured, the result is an estimate of the average amount of ^{14}C in the

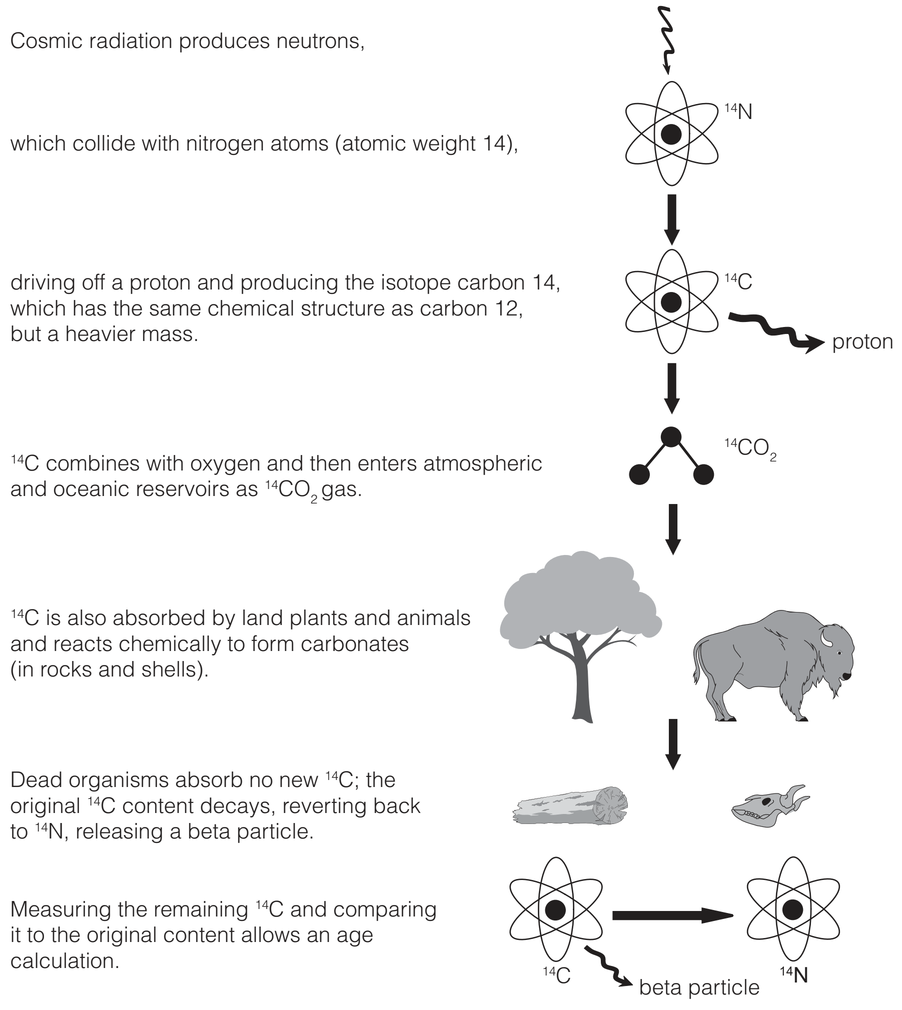

Figure 1.3
The radiocarbon process in schematic form; see text for a fuller explanation. (David J. Meltzer.)

sample, with an accompanying standard deviation to show the estimated error (the true value should fall within one standard deviation 68 percent of the time). For instance, an age of 10,130 ± 60 years BP puts the estimated age based on the mean of the emissions at 10,130 years BP, with a 68 percent chance that the true age falls between 10,070 and 10,190 years BP.

In principle, it takes over ~100,000 years for all the ^{14}C in a sample to decay (the continued halving those halves). Yet in practice problems of preservation, the difficulty of detecting the tiniest amounts of ^{14}C, and the potential for contamination of ancient samples by younger carbon, puts the presently reliable upper limit of radiocarbon dating at ~45,000 years ago.

The amount of ^{14}C in a sample can be detected in one of two ways: traditionally it was by decay counting, with a sample put in liquid or gas form, and set in a counter that tallied the beta emissions. The obvious problem: older samples with less ^{14}C have fewer and more widely spaced beta emissions, so obtaining a statistically reliable count took days, weeks, and sometimes months. The now more widely used technique is accelerator mass spectrometry (AMS) dating. Greatly simplifying matters, AMS dating works by accelerating carbon ions in a sample so they move at extraordinarily high speeds around a track. These are then passed through a magnetic field that causes the particles to deflect, the degree of deflection depending on their mass. Strategically placed detectors separately count the lighter ^{12}C and the heavier ^{14}C atoms. Ages are derived by determining the ratio of ^{14}C:^{12}C in the sample, as a fraction of the modern (1950) ratio of ^{14}C:^{12}C.[3] AMS dating takes minutes or hours, not days or weeks. Best of all, because atoms are counted directly, large samples are not needed. Prior to the advent of AMS dating, approximately 5 grams of carbon were required; now, it is on the order of 1 *milligram*. That's the difference between needing the entire limb bone of a giant bison, as opposed to the single tooth of a rodent, and it has greatly expanded our ability to date archaeological remains.

Useful as it is, radiocarbon dating is complicated by the fact that the ratio of atmospheric ^{14}C:^{12}C has varied over time, owing to fluctuations in ^{14}C production, driven by changes in solar activity and the amount of neutrons bombarding the atmosphere; changes in the earth's magnetic field, which shields the earth from ^{14}C-creating cosmic rays; and as a result of how much ^{14}C is stored in the world's oceans, which harbor far more CO_2 than the atmosphere (including "old" carbon depleted of ^{14}C). As a result, at times in the past there was more (or less) ^{14}C available for a living organism to absorb, and thus samples from those times will appear younger (or older) than their actual age.

To account for this variation, radiocarbon measurements are *calibrated* against materials whose ages are precisely known, the gold standard being the annual growth rings of a tree. A tree growing in the temperate zone adds a ring every year, and since most years differ from one to the next in rainfall and temperature, the rings often have different widths (wide and light colored if it's a good growth year, dark and narrow if not). The ring pattern becomes a fingerprint for particular periods, and there is now a pieced together record of those fingerprints that extends back to ~13,900 years – thanks to some well-preserved and long-lived trees from the American southwest and Europe (including wood from archaeological sites). Radiocarbon dating a tree ring of known age reveals the difference between a ^{14}C age and its true calendar age. Thanks to the radiocarbon research community, which has made ^{14}C measurements of many thousands of individual tree rings of known age, along with many independently dated corals, stalactites, and stalagmites, and annually deposited mud from lakes and deep sea basins, there is now a "calibration curve" that extends back 50,000 years, enabling us to calibrate (again, within statistical bounds) a radiocarbon age into true age.[4] An age in radiocarbon years ago is here denoted as "^{14}C years BP," and a calibrated age as "cal BP."

Radiocarbon ages and true calendar ages are equivalent back to ~3,000 years ago. Beyond that, the two steadily diverge: an age of 5,000 ^{14}C years BP is equal to 5,500 cal BP; 10,000 ^{14}C years BP to 11,485 cal BP; 15,000 ^{14}C years BP to 18,275 cal BP, and so on (Table 1.1).[5] But the radiocarbon and true calendar ages are not just diverging; the calibration line itself "wiggles" as a result of the

Table 1.1
Equivalence of radiocarbon and IntCal20 calibrated ages from 20,000–10,000 radiocarbon years BP at 500 radiocarbon year intervals

Radiocarbon ^{14}C years BP	**^{14}C interval in years**	**Median cal years BP**	**Cal interval in years**	**1 standard deviation range**	**1 SD (%)**	**2 standard deviations range**	**2 SD (%)**
20,000 ± 50	500	24,000	675	24,095–23,890	68.3	24,190–23,840	95.4
19,500 ± 50	500	23,520	480	23,740–23,355	68.3	23,765–23,285	95.4
19,000 ± 50	500	22,955	565	23,000–22,915	68.3	23,060–22,830	95.4
18,500 ± 50	500	22,405	550	22,455–22,355	68.3	22,505–22,315	95.4
18,000 ± 50	500	21,945	460	22,030–21,870	68.3	22,105–21,765	95.4
17,500 ± 50	500	21,115	830	21,220–20,970	68.3	21,355–20,935	95.4
17,000 ± 50	500	20,525	590	20,585–20,450	68.3	20,745–20,405	95.4
16,500 ± 50	500	19,930	595	20,040–19,850	68.3	20,130–19,620	95.4
16,000 ± 50	500	19,315	615	19,410–19,220	68.3	19,480–19,150	95.4
15,500 ± 50	500	18,805	510	18,850–18,765	68.3	18,885–18,710	95.4
15,000 ± 50	500	18,275	530	18,570–18,215	68.3	18,615–18,195	95.4
14,500 ± 50	500	17,670	605	17,810–17,520	68.3	17,900–17,430	95.4
14,000 ± 50	500	17,030	640	17,090–16,960	68.3	17,320–16,865	95.4
13,500 ± 50	500	16,275	755	16,360–16,185	68.3	16,470–16,085	95.4
13,000 ± 50	500	15,565	710	15,675–15,470	68.3	15,740–15,340	95.4
12,500 ± 50	500	14,700	865	14,970–14,540	68.3	15,035–14,340	95.4
12,000 ± 50	500	13,910	790	14,005–13,795	68.3	14,035–13,785	95.4
11,500 ± 50	500	13,380	530	13,430–13,320	68.3	13,485–13,245	95.4
11,000 ± 50	500	12,920	460	13,050–12,835	68.3	13,080–12,770	95.4
10,500 ± 50	500	12,540	380	12,620–12,470	68.3	12,685–12,105	95.4
10,000 ± 50	500	11,485	1,055	11,615–11,325	68.3	11,730–11,265	95.4

Note: The difference between radiocarbon and calibrated years can be seen in the fact that each radiocarbon age is separated by 500 years from the one above. However, the times between each of the corresponding median calibrated ages are shorter or substantially longer intervals (as shown in the 'Cal interval in years' column). Radiocarbon ages may have multiple intercepts on the calibration curve. Ages calibrated with *OxCal* 4.4 (https://c14.arch.ox.ac.uk/oxcal/OxCal.html).

waxing and waning of atmospheric ^{14}C/^{12}C ratios over time. Unfortunately the period of greatest interest in the study of the first Americans – the Late Pleistocene – was also a window of time during which there were significant changes in ocean circulation (for reasons explained in Chapter 2), which caused atmospheric ^{14}C concentrations to wiggle a great deal. A calibrated ^{14}C age thus does not point precisely to a single year but instead to a span of years. The extent of that span, which can even be discontinuous, varies according to where it falls on the calibration curve.[6]

Radiocarbon dating works on the remains of once living organisms such as charcoal or bone, but where these are not preserved or are otherwise problematic (for example when bone has been contaminated), there are alternative dating techniques.

The one most commonly applied is luminescence dating. It too works off a straightforward physical principle that can get complicated in the details. The earth is constantly bombarded with natural radiation, some of which is captured in certain minerals, especially quartz and feldspar. Over time, those trapped electrons accumulate within crystal lattices in the minerals. The more time that has elapsed, the more electrons collected in the traps. These can be released – which luminesces in the process – when the crystal is either heated (*thermoluminescence* [TL]), or exposed to photons of a specific energy range (*optically stimulated luminescence* [OSL]).[7] The amount of luminescence gives a measure of the accumulated electrons and hence the elapsed time of their accumulation. Like radiocarbon ages, luminescence ages have statistical error bars affixed to them, often 6–7 percent of the estimated age.[8]

Luminescence dating assumes that electron accumulation is constant over time (it generally appears to be); that the traps were completely empty to start with (that depends); and that once electrons began to accumulate, the traps were not subsequently emptied by exposure to heat or light that "reset" the clocks to start ticking at a later date (as, for example, might occur if sediment grains were brought to the surface by burrowing animals, and thus exposed to the sun and the traps cleaned out).

Luminescence dating can be applied to artifacts (for example, when the artifacts have been burned), but in the peopling of the Americas it is most often used to determine the age of quartz and/or feldspar grains in the sediment layers of an archaeological site, and so by extension the age of the artifacts and bones found in that layer. Because the age is not on the archaeological materials per se; because artifacts and bones can move around in the earth (again, think burrowing rodents); and because the electron traps may not have been completely empty when the layer was deposited – or the traps were reset later – there is not always a straightforward relationship between an OSL age for a deposit and its artifacts or bones.

Lastly, there are so-called molecular clocks. These are used to determine how long it's been since two groups were part of the same ancestral population (put another way, when they split from one another).[9] Put simply, they are based on the fact that after groups diverge from a common ancestor, each accumulates new mutations in their DNA; the longer they've been separated, the greater the genetic (mutational) "distance" between them. Distance is turned into time by making certain assumptions about the mutation rate, generation time, population demographics, and so on. Molecular clocks haven't the reliability of radiocarbon dating (the results can vary depending on the method used), nor are they as precise: the "error bars" (uncertainty) associated with molecular age estimates are routinely in the thousands of years. On the other hand, they enable us to put an age on a process that is otherwise invisible archaeologically – when groups started to separate from one another (Chapter 5).

OSL ages and molecular clock ages are equivalent to calendar ages (no calibration needed). It makes sense, therefore, to use calibrated radiocarbon ages, but there's a hitch: the calibration curve is constantly being refined. The current version, released in 2020, is known as IntCal 20. Loothatking ahead, there will be new and ever more precise editions. It is always easy to calibrate a radiocarbon age when a new calibration curve comes out. However, it is virtually impossible to "uncalibrate" a cal BP age calibrated from a previous version (IntCal13, IntCal09, IntCal04, etc.), making it difficult to compare ages calibrated using different curves. That's why we routinely list our radiocarbon ages: those don't change.

Throughout the book I use mostly calibrated ages; this will insure that time is always on the same scale, no matter the method. Occasionally, and where appropriate, radiocarbon ages will be provided – and identified as such. That's especially useful when referring to research and writing done before calibration came online in the last decade of the 20th century. If you think switching back and forth between calibrated and uncalibrated ages might be confusing, you're correct. But I will do my best to keep the right time.