



# Monumental Roots

The great stone monuments of prehistoric Britain, including Stonehenge, were born in a wave of innovation that apparently began on a remote Scottish island

## MAINLAND ISLAND, ORKNEY ISLANDS, U.K.

—To reach this hilly, windswept island in Scotland's far north, you must either catch a flight on a prop plane or else drive for hours through the fog-shrouded Scottish Highlands and cross 40 kilometers of often-choppy seas by ferry.

Once here on the largest of Orkney's 70 islands, you'll find peace and quiet. The mostly treeless hills are dotted with grazing cattle and scattered houses. But 5000 years ago, this faraway landscape was a center of Britain's new stone age—what we now call the Neolithic. Thousands of people gathered in the shadow of one of the world's most spectacular clusters of stone monuments, according to recent excavations and dating.

Sometime around 3200 B.C.E., in the middle of a narrow isthmus that divides a freshwater loch from a salty one, hundreds of people labored to construct a complex of elaborate stone buildings covering at least 10,000 square meters, more than two American football fields. Called the Ness of Brodgar, its thick stone walls, richly adorned with mysterious engravings, may have served as a ritual center not only for Orkney islanders, but also for pilgrims from the Scottish mainland. A few hundred years later, on the south end of the isthmus, the Orkney people erected the Stones of Stenness, a dozen stone pillars up to 6 meters tall, arranged in a circle. A much larger monument, the 104-meter-diameter Ring of Brodgar, rose soon after at the isthmus's

northern end. Teams of laborers dragged 60 monoliths, up to 4.5 meters tall, from quarries as far as 15 kilometers away.

A flurry of discoveries and research across the British Isles is giving archaeologists a new perspective on just why ancient people erected these statements in stone. At Stonehenge, for example, important new insights are coming not just from the stone pillars themselves, but also from a once-bustling settlement 3 kilometers away (see sidebar, p. 20). The work emphasizes how monuments served as social glue to bring geographically dispersed communities together in ritual activities. The process of megalith construction may have been as important as the grand final product. "It may be the act of building that's important, bringing people

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**Stone sentinels.** Orkney's Ring of Brodgar has been standing for nearly 5000 years.

together and sharing and pooling labor," says Mark Edmonds, an archaeologist at the University of York in the United Kingdom.

The new findings also tell a surprising story about the origins of Britain's megalithic monuments ("mega," meaning huge, and "lithic," or stone): They started here on Mainland Island in Orkney, along with new styles of architecture and a special kind of pottery. From this remote, 520-square-kilometer island, these innovations swept nearly every corner of Britain and Ireland, culminating in the famous monuments of Stonehenge and Avebury in southern England. "We're looking at a fairly major transformation across Britain, the impact of a whole way of life, religious and social, which comes out of Orkney," says archaeologist Michael Parker Pearson of University College London (UCL), who has led recent excavations at Stonehenge and surrounding monuments. "Orkney was a place of synthesis, where Neolithic worlds came together."

### Farming arrives, dirt mounds arise

People began erecting stone monuments as early as 11,000 years ago, as vividly attested by monoliths carved with strange animal images at the site of Göbekli Tepe in southeastern Turkey (*Science*, 18 January 2008, p. 278). Göbekli Tepe was erected on the very cusp of the so-called Neolithic Revolution, when farming began to spread. But nearly all other stone monuments are later, from the Neolithic period, and most archaeologists think the advent of farming somehow made megaliths either possible or desirable.

Back in the late 1990s, Richard Bradley, an archaeologist at the University of Reading in the United Kingdom, argued that most hunter-gatherers see themselves as one with nature, not apart from it. So they wouldn't think of altering the landscape by erecting stone structures, whereas farmers are all about changing nature. The contrasting worldviews "make very good sense," Bradley says. And there's no doubt that building in stone took off as farming spread to Europe beginning about 8500 years ago. That's when people began burying their dead in stone chambers and erecting stone pillars, especially along Europe's coasts. For example, early farmers

aligned thousands of menhirs (standing stones) at Carnac in Brittany.

But truly massive monuments often lagged behind the beginnings of farming, as a new dating program led by archaeologist Alasdair Whittle of Cardiff University and dating expert Alex Bayliss of English Heritage's London Office has shown. Stone monuments are notoriously hard to date, because radiocarbon techniques require organic material. So archaeologists look for datable remains among associated animal bones, charcoal, or artifacts.

Bayliss and others also apply powerful mathematical techniques called Bayesian statistics to both newly gathered and older dates, boosting accuracy (*Science*, 15 September 2006, p. 1560). When applied to Britain's earliest monuments,

this approach can pinpoint construction to within 40 years or less, allowing Whittle and Bayliss to track monument building generation by generation. The approach "is superb, agenda setting, and groundbreaking," says archaeologist Andrew Jones of the University of Southampton in the United Kingdom.

The team found that farming practices such as cereal cultivation and animal domestication, and the appearance of pottery and timber houses, all began in southeast England a generation or two before 4000 B.C.E., then spread across Britain. But at first these farmers built only smaller structures, like tombs, in stone. "You seem to get a gap before the first appearance of monumentality," Whittle says. He and others think that as farmers migrated into the British Isles from the European continent, perhaps recruiting resident hunter-gatherers to the new way of life, it took several generations for farming populations and social complexity to develop to the point that giant monuments were both possible and meaningful.

In Britain, the first great monuments weren't made of stone but of earth.

## Online

**sciencemag.org**

**S** Podcast with author Michael Balter and slideshow of monuments ([http://scim.ag/med\\_6166](http://scim.ag/med_6166)).



**Mysterious meanings.** The interior walls of the Ness of Brodgar were decorated with "butterfly"-shaped symbols.





## Life and Death at Stonehenge

**DURRINGTON WALLS, U.K.**—From all over Britain they came by the thousands, with their families, their pigs, and their cattle, to this huge complex of earthen and wooden monuments by the River Avon, known today as Durrington Walls. Inside a circular earthen bank and ditch, 500 meters in diameter, stood a smaller circle of dozens of stout, upstanding timbers. In the center, the body of a venerated chief lay in state. The pilgrims feasted to his triumphs and to his memory, roasted their cattle and their pigs, and then the procession began.

Thousands marched down the short avenue to the river. The chief's body was loaded into a waiting boat, and a smaller contingent pushed off down this tortuous stretch of the Avon. A few hours later, the burial party alighted on the riverbank, joined by new throngs. Together they marched down another, longer avenue to the somber stone megalith now called Stonehenge. There, the body of the chief was placed atop a flaming pyre, and his spirit joined the ancestors.

This scenario is imaginary, but it's also completely consistent with new studies of the monuments and the animal teeth and bones buried among them. The findings are finally bringing Stonehenge, the most dramatic expression of the megalith movement that swept the British Isles 5000 years ago (see main story), out of the realm of mystery, and they are confirming new ideas about its ritual purpose. "It's nice to think that what started out as a theory turned into

fact," says archaeologist Michael Parker Pearson of University College London (UCL), who has led digs around Stonehenge.

The new data support Parker Pearson's picture of Stonehenge as the place of the dead, and Durrington Walls as the place of the living. At Stonehenge, archaeologists have found more than 60 cremation burials, for example, but few animal bones or residences. At Durrington Walls, they have recovered more than 80,000 pig and cattle bones, but only three fragments of human remains. Stonehenge and Durrington Walls "were exactly the opposite," Parker Pearson says.

The two monuments, 3 kilometers apart as the crow flies, were built about the same time, 4600 years ago, according to dates on a pig bone and antler pick, first reported in 2008 (*Science*, 27 June 2008, p. 1704). Researchers also discovered a short earthen roadway from Durrington Walls to the Avon, resembling Stonehenge's longer avenue to the river and showing that both monuments were connected to the river and so to each other. The life versus death model "holds up very well," says Joshua Pollard, an archaeologist at the University of Southampton in the United Kingdom.

The rituals at the monuments were sometimes accompanied by great feasts, possibly around the winter solstices. (Stonehenge is aligned to the winter and

summer solstices.) Zooarchaeologists can estimate when a pig was killed by the amount of wear on its teeth, and unpublished results show that most were killed in winter, says zooarchaeologist Umberto Albarella of the University of Sheffield in the United Kingdom.

Right next to Durrington Walls, excavators have found a village with a population that might have been in the thousands, with houses built in a style—including the placement of the beds and a central dresser—that apparently originated in far-off Orkney. Parker Pearson and others are confident that the people who lived there helped build the monuments, and the huge number of animal remains suggests that whoever was in charge of the vast project had to keep them well-fed. Other researchers have found that pottery from the village—manufactured in the Grooved Ware style first seen in Orkney—held rich traces of both dairy products and pig fat.

New evidence also supports the idea that Durrington Walls and Stonehenge served the ritual needs of a widespread



**Ritual landscape.** Durrington Walls (land of the living) and Stonehenge (resting place of the dead) were linked by the Avon River; other monuments, such as the Greater Cursus, were nearby.

British farmers built causewayed enclosures—deep, concentric circular ditches and banks, with narrow passageways so visitors could penetrate successive rings and reach the center. This phase lasted only about 400 years, according to the dating program, and was quickly followed around 3300 B.C.E. by another kind of earthen monument: the cursus. These linear structures are made up of two high, parallel banks with a ditch outside of each one. Cursuses are British originals, built only in these isles, though they,

too, were short-lived, in use for only about 300 years.

Up in Orkney, these earthen styles never took root, however. Instead, about 5000 years ago, the people of Orkney invented a new kind of monument—one that transformed the face of Britain.

### North to Orkney

When archaeologists first glimpsed the Ness of Brodgar, after a farmer plowed up a notched stone in 2003, they had never

seen anything like it. The warren of interconnected stone buildings of various sizes remains unique in Europe, in both size and construction. To date, a team led by Nick Card, an archaeologist at the Orkney Research Centre for Archaeology (ORCA), has excavated about 10% of the site's 25,000 square meters, uncovering about a dozen stone buildings. One, thought to be a temple or meeting hall and located at the center of the complex, was 500 square meters in area and incorporated a cross-shaped interior



**Celebrating the sun.** The winter solstice may have been a time for rituals at Stonehenge and Durrington Walls.

population. Albarella and his Sheffield colleague Sarah Viner analyzed strontium isotope ratios in cattle teeth from the site, which vary in different geological landscapes and so can indicate where animals were raised. They found that fewer than 20 of nearly 70 tested teeth came from the chalklands around Stonehenge; the rest came from elsewhere in England and Wales. A more precise analysis using ratios of oxygen isotopes, which can reveal the location of the water the cattle drank, suggested that many came from Wales and Scotland. “Cattle will not have traveled alone,” Albarella says. “There was a gathering of people coming from many different regions, thus supporting the view of the site as potentially ceremonial.” The one human tooth found at Durrington Walls also originated far from the site, although the team can’t pinpoint just where.

These results have sparked hypotheses that far-flung hierarchies and social stratification might have been the driving forces behind the monuments. “The burials at Stonehenge might reflect some kind of royal dynasty, and Stonehenge [itself] reflect some kind of political unification,” says archaeologist Alasdair Whittle of Cardiff University in the United Kingdom.

Stonehenge and Durrington Walls might have been a unifying center for all of prehistoric Britain, or at least its southern half, Parker Pearson says. That might explain why Stonehenge’s bluestones—so named because the dol-

erite and rhyolite blocks take on a slight blue sheen when wet—were either dragged, transported on boats, or both, all the way from the Preseli Hills in Wales. Geologists Richard Bevins of the National Museum of Wales in Cardiff and Rob Ixer, now at UCL, put bluestone samples under the microscope and were able to tie them to a handful of outcrops in the hills’ northern slopes. The rhyolite bluestones came from a Preseli outcrop called Craig Rhos-y-felin, the pair suggested last year. Most of the dolerite bluestones came from another outcrop called Carn Goedog, the researchers report in a paper in press in the *Journal of Archaeological Science* and published online in November. There, bluestone pillars cling to a hillside, ripe for quarrying.

Parker Pearson and his colleagues are now excavating in the Preselis, looking for the very quarries where the bluestones began their journeys to Stonehenge, some 225 kilometers away. They conclude that the prehistoric people of Wales knew about far-off Stonehenge, and its rituals for the living, and for the dead. —M. B.



**Celebrated circle.** Henge monuments like Stonehenge include a circular earthen bank and ditch, with the great standing stones in the middle.

room or sanctum; Card calls it “the cathedral.” Most buildings feature walls up to 4 meters thick and internal divisions made of stones incised with mysterious “butterfly” patterns (see photo, p. 19). The whole complex was surrounded by an outer stone wall spanning up to 100 meters, almost the entire width of the isthmus. Radiocarbon dates on charcoal found under a section of this wall, and of cattle bones in one of the later buildings, indicate that the complex was first occupied about 3200 years ago and

was used for about a thousand years.

Whatever was going on at the Ness was apparently accompanied by feasting on a very large scale. In the “cathedral” building, the team found shin bones representing hundreds of cattle, deposited near the end of the life of the Ness around 2300 B.C.E. Pottery is everywhere, and unpublished analyses of residues in the pots by researchers at the universities of Bristol and York show that about half the pots contained fats from cattle carcasses, and half fats from dairy products.

These latest discoveries emphasize the importance of monuments as places where people came together to perform rituals. “The Ness was the hub of a huge wheel that took in at least all of the islands and chunks of the mainland as well,” Edmonds says. “It was the center of their universe.” Colin Renfrew, an archaeologist at the University of Cambridge in the United Kingdom, agrees. “This was a major ceremonial and ritual center that must have served for the whole of Mainland Orkney and the

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**Stone Age Mecca.** The Ness of Brodgar was strategically located, occupying the width of a narrow isthmus between two lochs, on Orkney's Mainland Island.

whole of the islands in general. It was a very special place.”

While the Ness was still in use, the people of Orkney had another original idea: They combined earthworks and stone pillars to create the first henge and stone circle monuments, a type of megalith seen only in Britain. Strictly speaking, the term henge does not refer to the great stone circles, but to the earthwork bank lined with a circular ditch that surrounds the stones. (Stonehenge is one of the few exceptions, because its ditch is outside the bank; some purists insist that it is thus not a true henge.) Today, only four of the original 10 to 12 of Orkney's Stones of Stenness on the eastern edge of the isthmus remain. But the sockets of most of the rest, as well as the earthen bank and ditch, can clearly be seen—and they date to at least 4800 years ago, some 200 years before Stonehenge rose, according to Bayliss's preliminary reanalysis of existing radiocarbon dates. About the same time, according to new dates from optically stimulated luminescence, the people of Orkney built a second henge, the even larger Ring of Brodgar, at the north end of the isthmus.

By this time, people in continental Europe had been building stone monuments for

many hundreds of years. But when the people of Orkney expressed themselves in stone, they found a new way to do it. “Our monuments are not replicas of those in Brittany,” says Vicki Cummings, an archaeologist at the University of Central Lancashire in Preston, U.K. Stone circles are rare in France, and henges are found only in Britain.

Many archaeologists think it likely that the great stone pillars represent ancestors, arguing primarily from ethnographic examples. But Colin Richards, an archaeologist at the University of Manchester in the United Kingdom, thinks he has found other clues to the meaning of the Orkney stones. During the 1970s, archaeologists discovered that the Stones of Stenness came from at least five different sources on the island. Recently, Richards teamed up with geologists and found that the 27 remaining sandstone pillars in the Ring of Brodgar appear to come from at least seven far-flung sources up to 15 kilometers away on Mainland.

Richards surmises that different communities on the island were dragging stones to this narrow isthmus in what he sees as a delicate balance of cooperation and competition. “Brodgar was a place where differ-

ent groups were competing. It was all about dragging the stones from different places, and the ability of certain groups to mobilize labor,” he says. “Stones have never been moved on that scale before. Something is happening that has never been attempted. It's a spectacle, and people are going there to watch, as much to see it fail as to succeed.”

Card says megalith building might have been key to the development of stratified societies during the Neolithic. “Who could mobilize the most people, who could quarry and bring the biggest stones—that kind of competition encouraged the development of hierarchies.” He and others cite plentiful evidence for the growth of hierarchies across Britain beginning about 5000 years ago, including more elaborate tombs and clusters of sophisticated stone houses. On Orkney, for example, the famous stone village of Skara Brae on Mainland's west coast and a village called Barnhouse, right next to the Stones of Stenness, appear to have housed some kind of elite. And the spectacular chambered tomb of Maeshowe, clearly intended for the Neolithic upper crust, lies just 1.5 kilometers east of the Ness of Brodgar.

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## Celebrated ceramics

Other innovations accompanied the great monuments. The people of Orkney also invented a widespread and distinctive pottery style called Grooved Ware, with flat-bottomed vessels decorated with deep incisions (see photo, below). Recent work shows that this pottery dates back to 5100 to 5300 years ago on Orkney—before its appearance anywhere else, including Ireland, which had been considered a candidate for its place of origin.

Because pottery is usually associated with the organic remains of daily life such as charcoal and animal bones, it is easier to date than stone monuments. And because the Grooved Ware style is closely linked with henge monuments all over Britain, many archaeologists consider the pottery a more reliable chronological marker for the spread of megaliths than the stones themselves. Sometime after 2800 B.C.E., after the first megaliths on Orkney had been built, Grooved Ware shows up all over England, including at Durrington Walls, a large settlement closely associated with Stonehenge, and near three spectacular henges at Thornborough in Yorkshire, says Jan Harding, an archaeologist at Newcastle University in the United Kingdom who recently led excavations at the site.

“The idea of decorating a pot this way traveled with a wider cultural package, which included henges and standing stones,” says ORCA archaeologist Roy Towers, who leads the study of the Grooved Ware pottery at the Ness of Brodgar. “These must have been very powerful and attractive ideas.” Parker Pearson agrees: “For the first time since the arrival of farming there is a truly indigenous inspiration in architecture and ceramics and other aspects of life. ... And it was the peripheries,” rather than the mainland, “that provided the radical ideas.”

Orkney is also the source of a distinctive style of house building, found during Richards’s excavations at Barnhouse and other sites in the islands, including Skara Brae. These houses featured a central hearth, stone beds, and a stone “dresser” probably used to store household items. About 300 years later, houses with just that layout appear at Durrington Walls and other sites associated with megaliths.

## Only in Orkney

Why lonely Orkney was the birthplace of all these innovations is largely a mystery, but researchers have some clues. For starters, Orkney was apparently a magnet for early cereal farmers, who could have sustained the large population needed to build the monuments. Based on the labor it took to build

the island’s megaliths, Card says, “we are looking at a population of 10,000 or more.” Although cereal cultivation arrived in Britain around 4000 B.C.E., it was quickly supplanted in most of the region by herds of cattle, sheep, and pigs, according to work published last year in *Antiquity* by archaeologists Chris Stevens of Wessex Archaeology in the United Kingdom and Dorian Fuller of UCL. But Orkney and other Scottish islands were a major exception. For example, the recently excavated settlement called Ha’Breck, on the tiny island of Wyre northeast of Mainland, yielded tens of thousands of charred barley grains, more than any other Neolithic site in Britain. There was “a significant divergence in terms of subsistence practice between the mainland and the islands,” Stevens says.

One controversial idea is that northern Scotland (including the Orkney Islands) and England were colonized by different groups of European farmers, and that Orkney might even have been colonized twice. But were these supposed European newcomers responsible for the cultural innovations on Orkney? Yes, some researchers suggest, citing the com-



**In the groove.** This incised pottery was invented in Orkney and spread through Britain along with megalithic monuments.

mon vole, *Microtus arvalis*. This grass-eating rodent lives all over continental Europe but is completely absent from the British Isles except for one place: the Orkney Islands. The so-called Orkney vole has long been a source of mystery, and its tiny bones have been found at many Neolithic sites on the islands.

The vole was introduced into the Orkney Islands at least 5100 years ago at sites with the earliest Grooved Ware pottery, according to work reported in *Molecular Ecology* last September. Ancient and modern DNA suggests that the vole was most closely related to either

Belgian voles or those from northern France, according to a team led by evolutionary biologist Jeremy Searle of Cornell University and archaeologist Keith Dobney at the University of Aberdeen in the United Kingdom.

The data suggest that the voles arrived too late to have stowed away with the very first farmers on Orkney, who arrived at least 5500 years ago. Rather, researchers suggest that the rodents came hundreds of years later, perhaps via a second wave of immigrants. Voles easily could have stowed away in animal fodder that farmers were bringing to the islands by boat, Dobney says. In this scenario, the encounter between new migrants and an unfamiliar environment somehow sparked dramatically new cultural innovations, including Grooved Ware pottery and the creation of magnificent megaliths.

Not everyone is convinced by the vole story. No artifacts, such as pottery, link prehistoric Belgium and the Orkney Islands, points out archaeologist Alison Sheridan of the National Museum of Scotland in Edinburgh, who finds the DNA evidence unconvincing. “The arrival of the voles should not be equated with the arrival of new farming groups,” Sheridan says.

Wherever the builders of the Orkney monuments came from, their massive creations still stir the imagination. The arrangement of monuments all along Mainland’s narrow isthmus, which links two large arable regions, suggests that it was the site of periodic processions of people from all over the island, says archaeologist Jane Downes of Orkney College on Mainland. The way the Ness completely occupies the narrowest part of the isthmus suggests to some that an elite controlled this strategic place. “You can imagine people and animals moving up and down ... this ancient route,” Downes says.

As they entered the Ness, pilgrims perhaps carried torches to light the dark, stone hallways, and they would have gazed on the red painted walls incised with engravings left by their ancestors. “People were being choreographed in movement through the Ness. Everything was hidden from view by its monumental wall,” Card says. Once they had reached the “cathedral,” they feasted on roasted cattle and performed the rituals that their culture demanded. “Then you get inside and here are all the wonders. It was like Mecca. It was the end of the journey.”

—MICHAEL BALTER