cian. Then in 1979, Neandertal bones were found in a layer with Châtelperronian tools. Now, says Hublin, it seems Neandertal artisans made Châtelperronian artifacts just about the time that Cro-Magnon people invaded the region. There is fierce debate over whether Neandertals imitated the nearby modern humans or invented this culture independently (*Science*, 20 November 1998, p. 1451). Regardless, the timing implies contact: "It was clear that Neandertals in some spots survived the arrival of modern humans," says Hublin. "They were the makers of some of these transitional industries, not the modern humans."

And some archaeologists now argue that the Châtelperronian is not unique. Other sites in Italy, Greece, and central Europe, where the most complete archaeological trail exists for this time, indicate that Neandertals were not just copycats but were experimenting with more modern tools and behavior. "Everyone believed in the sequence of Mousterian, Châtelperronian, Aurignacian," says archaeologist Janusz Kozlowski of Jagellonian University in Cracow, Poland. "Now we know the transitional technologies are much more rich."

More than 20 different technologies, for example, have been identified in archaeological sites in central Europe. No one knows who made these tools 45,000 to 30,000 years ago, because no diagnostic human remains are associated with them. But Kozlowski argues that at least two of the cultures, the Bohunician and the Szeletian, may have been made by Neandertals. The Bohunician is early—45,000 years ago in Moravia—and the blades, although modern, retain many of the steps from a late Mousterian style of producing flakes from a stone core, combining old methods with new blade production. These ancient people were experimenters: A bit later, they used methods more like those of the Upper Paleolithic to haft blades. "This means these people were able to produce tools according to different sequences of movement," says Kozlowski. "This flexibility shows more complex cognitive abilities."

The other technology with possible Neandertal ties, the Szeletian, was found with a Neandertal mandible in the Szeleta Cave in Hungary. Although that is not proof that Szeletians were Neandertals, the Szeletian may well have been the work of some of the last Neandertals, says Northern Illinois's Smith. And these toolmakers apparently had contact with the Aurignacians. Szeletian tools have been found at Aurignacian sites in Slovakia, and Aurignacian bone points have been found at Szeletian sites, although there is no evidence as to whether the contact was friendly, hostile, or direct.

Retreating south

There are also signs that Neandertals were aware of modern humans' presence in Italy, where three distinct traditions coexisted between 40,000 and 30,000 years ago. The early Aurignacian (characterized by many little bladelets, rather than large blades) appeared in northern Italy almost 37,000 years ago. At that time, the late Mousterian tools began to include more blades, and the Mousterian people—the Neandertals—moved out of northern Italy, says Arizona's Kuhn, who has worked at Italian sites. And another new transitional technology, known as the Uluzzian, appeared in central and southern Italy. There are no diagnostic human remains linked with this culture, but the Uluzzian is completely different from the Aurignacian and at some sites predates it; thus, Kuhn thinks it is the handiwork of Neandertals.

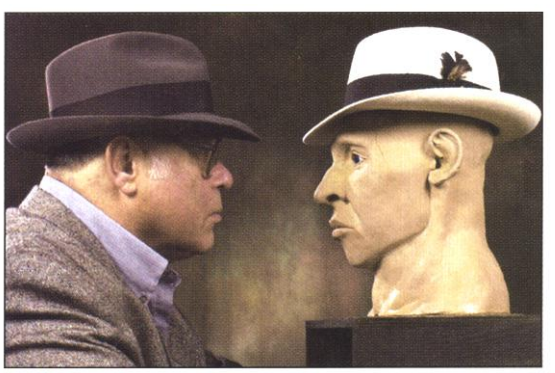
This pattern, of extended coexistence and slow movement south into refuges by the Neandertals, is best documented in Iberia by a trail of Mousterian and Aurignacian tools. The Aurignacian tools appeared

Anthropologists Duel Over Modern Human Origins

LONDON—Chris Stringer carefully lays the wooden box on a long table cluttered with scientific journals. He unfastens the latch, opens the top, and gingerly lifts out a human skull that is perhaps 400,000 years old. As Stringer gently turns the cranium in his hands, its appearance is startling. The flat, nearly vertical midface and large brain cavity could almost be mistaken for those of a modern human. Yet above the eyes, heavy browridges and a sharply receding forehead distinctly recall *Homo erectus*, a long-extinct early human. "It's modern, and yet not modern," Stringer tells a visitor to his office at London's Natural History Museum.

The paradox of fossils like this one from Broken Hill, Zambia, with its mixture of ancient and modern traits, has sparked one of the most bitter and longest running battles in paleoanthropology. Stringer is a leading proponent of what many consider the dominant theory—that humans with such transitional features belonged to transitional species, in this case one often called *Homo heidelbergensis*. According to how Stringer reads the fossil record, an unbroken evolutionary chain in Africa may link this species to modern humans, who then swept around the globe, replacing already-settled human populations such as the Neandertals in Europe (see main text) and perhaps even *H. erectus* in Asia.

But although this "Out of Africa" scenario is established in many media and textbook accounts, a staunch band of skeptics, led by paleoanthropologist Milford Wolpoff of the University of Michigan, Ann Arbor, holds to an opposing theory called multiregional evolution. In this view, the evolution of modern humans has been occurring across the globe since early humans left Africa nearly 2 million years ago. Thanks to continuous exchanges of genes among populations in different regions, humans have always belonged to one species and have evolved together into today's modern form. For Wolpoff, there is no such thing as "*H. heidelbergensis*": Such a mix of modern and ancient features reflects normal variation within a species. Nor does Wolpoff concede that his view is in the minority. "I think paleoanthropologists are split right down the middle on this," he says.



Close kin? Milford Wolpoff thinks that the ancestors of modern humans included European Neandertals like his reconstructed companion.

CREDIT: PAUL JARONSKI/UM PHOTO SERVICES

As leaders of two irreconcilable scientific camps, Stringer, 53, and Wolpoff, 58, have come to personify this bitter debate. And indeed, the argument has often become personal. "Milford and I have had some nasty exchanges," Stringer admits. In one 1989 article, Wolpoff ridiculed the idea that modern humans had replaced Neandertals as a "scientific rendering of the story of Cain," adding that this scenario's "violent" implications were "not pleasant." And Stringer, in his 1996 book *African Exodus*, co-written with Robin McKie of the London-based *Observer* newspaper, countered that "attention to inconvenient details has never been part of the Wolpoff style of rhetoric." The last straw, Wolpoff says, was a 1997 opinion piece in *The New York Times* cosigned by Stringer and McKie. The article contended that a

at about 36,500 years ago and coexisted with Mousterian artifacts for some time. But the Mousterian tools persisted in Iberia—and are even associated with Neandertal remains in Columbeira and Figueira Brava near Lisbon—until 30,000 to 28,000 years ago, making Iberia one of the last Neandertal holdouts, says archaeologist Joao Zilhão of the Portuguese Institute of Archaeology in Lisbon.

The record from these far-flung sites taken together suggests that the replacement of the Neandertals was slow (see map on p. 1725). At first, they remained entrenched in their homelands, but eventually they moved into southern Italy and Iberia and into the Balkan and Caucasus mountains. Something—either modern humans coming from the north or a climatic cooling during this time—prompted them to give up their "home field advantage," says Kuhn. "When the new people got there and started eating the same foods, life became a little more uncertain; there was a little competition for who got the game first." And he thinks that competition for resources—not necessarily direct contact—could have spurred the Neandertals, who had been living the same way for millennia, to make changes: "I think that when times got hard, Neandertals came up with better tools. It shows what they were capable of when you pushed them."

This competition, says Kuhn, may have inspired changes in "the other guys, too"—modern humans. "Suddenly, they ran into these really intransigent locals. It would have affected them, too," says Kuhn. He notes that the most complex Paleolithic art and culture appeared only in Europe, although modern humans emerged earlier in Africa, the Middle East, and Australia. He speculates that this flowering of culture was in part a reaction to competition with another kind of human.

Eventually, the Neandertals disappeared, perhaps because they were unable to rebound when the climate turned frigid starting 28,000 years ago and competition for prime land became harsher, speculates Bordeaux's Hublin. Moderns had some subtle advantage—perhaps slightly better language or abstract reasoning skills, or even a shorter interval between births of babies—that meant the difference between survival and extinction, say Pilbeam and Bar-Yosef.

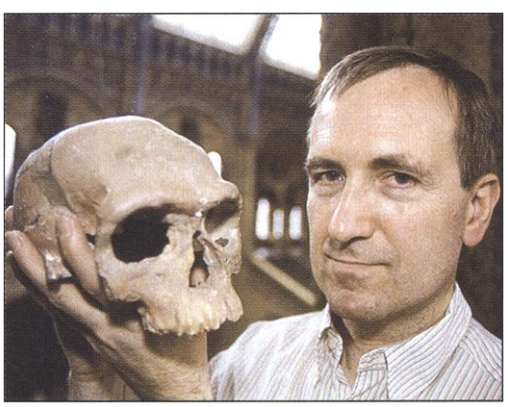
But not everyone is buying the idea of a long coexistence, with Neandertals as resourceful experimenters. Stanford archaeologist Richard Klein, for example, says that most Neandertals simply couldn't match the symbolic sophistication of the moderns. He considers the Châtelperronian "the only compelling indication of overlap" between moderns and Neandertals. And he warns that many of the sites of the "transitional technologies" and of the latest persistence of Neandertals have dating problems. The period from 60,000 to 30,000 years ago is at the limits of radiocarbon dating, so the resulting dates can easily be skewed by tiny amounts of recent carbon contamination and cause errors spanning 5000 to 40,000 years—enough to make it seem that Neandertals and moderns coexisted far longer than they really did.

Bar-Yosef responds that dates from dozens of sites show "a clear geographic pattern" indicating long periods of overlap. "If you go one by one, you can find problems with individual dates, but the general trend isn't going to change," he says. Nonetheless, he agrees that an international effort to redate key sites is needed to nail down precisely when this last transition from one type of human to another took place. "What happened with these two populations happened over and over again," notes Pilbeam. "It's just that this interaction was recent enough that we are able to detect it."

–ANN GIBBONS

recent African origin implies that racial differences are superficial and that "we are indeed all Africans under the skin." On the other hand, it concluded, "some scientists and those with narrow political agendas have put forward arguments to sustain the idea that races exist with fundamental biological differences." Wolpoff believes the article implied that his views make him a racist and says he has "not been on speaking terms with Stringer" ever since. (Stringer says the article was aimed at right-wing organizations, not Wolpoff.)

Yet despite their acrimonious disagreements, there are interesting parallels in the routes the men took to opposite conclusions. Both trace their interest in fossils to early childhood. As a youngster, Stringer often visited London's Natural History Museum, and Wolpoff says he was "astounded" to learn in college that "there was actually a profession" devoted to this hobby. While a graduate student at the University of Bristol in the early 1970s, Stringer spent 4 months traveling through Europe in an old Morris Minor, examining fossil skulls in museums across the continent. The data he gathered, including measurements of a nearly modern skull from North Africa, led him to question then-popular notions that Neandertals were our ancestors. Meanwhile, after receiving his Ph.D. from the University of Illinois, Urbana-Champaign, in 1969, Wolpoff took off on his own series of fossil tours, visiting Africa, Asia, and Australia. He began to develop his ideas about multiregional evolution, he says, when he realized that humans from Asia and Australia had retained some traits over several hundred thousand years, even as other features changed. "Asian features are found at all time periods," he says. For example, skulls from China always have small, forward-facing cheeks, flat noses, and very little facial projection, whereas ancient skulls from Australia are "robust and prognathic" with "huge cheeks" that he says are reflected in the features of some living Australian Aborigines.



African advocate. Chris Stringer argues that modern humans descended from Africans like this fossil hominid from Zambia.

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Despite the sometimes heated argument, admirers of both Stringer and Wolpoff insist that each man bases his views on science. Stringer "has always tried to convince by scientific results," says paleoanthropologist Günter Bräuer of the University of Hamburg in Germany, an early proponent of the Out of Africa theory. And biological anthropologist John Relethford of the State University of New York College at Oneonta, who has often questioned the Out of Africa camp's genetic evidence, says that Wolpoff "has studied virtually every [fossil]. ... He has a keen sense of variation across time and space."

Yet it seems unlikely that either side will convince the other anytime soon. Two months ago, the multiregionalists mustered both genetic and fossil evidence that they say bolsters the case for continuous evolution (*Science*, 12 January, pp. 230 and 231). Wolpoff says he thinks the argument will go on until he, Stringer, and other members of the opposing camps retire. "Then you will know how the debate turned out, by seeing what the new generation thinks." As for why the debate has become so emotional, Stringer says: "Scientists show the same frailties as the rest of the human species, especially when talking about our own origins."

–MICHAEL BALTER