Skeleton key

A climate that can carve landscapes can sculpt bodies too. **Jay Stock** compares skeletons, past and present.

Over many generations climate chisels away at the features of a species. In warm climates long, slender bodies shed heat, keeping animals cool. As temperatures drop, body heat must be retained at all costs. Animals put on weight and their limbs shorten to reduce heat loss, keeping the cold at bay. Skeletons become short and broad.

The short and broad physique maximises volume and minimises surface area of the body, trapping heat, increasing the chance of survival. If this helps an animal live to maturity and find a mate, the genes for this physique may be passed on to the next generation. Evolution takes its course.

We are no strangers to the same evolutionary forces. One look at the tall, slender people from the tropics compared to shorter, stockier northerners demonstrates how subtle adaptations can increase our own chances of survival.

Climate has played a major role in shaping human evolution. Neanderthals, the extinct species most closely related to modern humans, successfully lived in Europe for approximately 200,000 years until either climate change or competition for resources with modern humans, drove them to extinction 30,000 years ago. Temperatures fluctuated dramatically throughout this time, with many periods of harsh cold compared to the warmth and stability since the end of the last ice age, 10,000 years ago.

Neanderthals were very different from us in a number of ways. They were heavier, had short limbs, a long trunk, and large joints throughout their bodies. Neanderthals also had broad chests and wide hips compared to modern humans. They had shorter forearms and lower legs, and were extremely muscular, with bones that were considerably stronger than our own.

Modern humans originated in eastern Africa approximately 200,000 years ago. When the first modern humans migrated

to Europe over 40,000 years ago they had long limbs and narrow bodies like most East African populations today, and bones that were not as strong as the Neanderthals. This leads to important questions: why were the skeletons of Neanderthals and early modern humans so different? Can we explain the unique traits of Neanderthals by adaptation to the cold climate of glacial Europe? Were modern humans different because they had more effective technology?

The challenge of understanding human evolution from skeletal remains is to determine whether the differences in the skeleton relate to many individual genetic differences, or whether they can be explained by major changes in factors such as growth and development, adaptation to climate, or habitual behaviour.

The breadth of a body is the most important adaptation to climate.

In theory the breadth of a body is the most important aspect of adaptation to climate, as a wider body minimises heat loss in cold climates. This prediction is supported by global comparisons of modern humans, and seems to explain the wide bodies and large joint sizes of Neanderthals. The tall and thin physical features of the first modern Europeans also support this picture, and suggest that they were more recent migrants from Africa. Over thousands of years, the limbs of modern humans in Europe became shorter, suggesting that they gradually adapted to the colder climates of Europe.

While climate seems to explain much of what is unique about Neanderthals, does it explain other differences such as their strong skeletons? We know that strenuous activity increases the thickness and strength of bones. Professional tennis players grow stronger bones in their dominant arm, and a similar level of asymmetry is found among Neanderthals. Our understanding of the relationship between bone strength and activity suggests that the strong skeletons of Neanderthals reflect the very strenuous workload they required to survive. The relatively weak skeletons of early modern humans have often been interpreted as evidence that more complex culture allowed us to survive on the basis of technological innovation rather than strength.

These explanations of differences between Neanderthals and modern humans make intuitive sense and fit much of the archaeological evidence, but does this mean that they are correct? One of the problems of interpreting evolution from fossils is that it is not always clear whether features we see are due to adapting to climate or due to random differences between species that may result from geographic isolation. We can investigate the way in which adaptation and evolution works by studying variation within our own species. Although all living humans share a recent common ancestry within Africa, we have dispersed to all habitable regions of the world. In the process, we have adapted to different

David Keith Jones/Images of Africa Photobank/Alamy

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Bryan & Cherry Alexander Photography/Alamy

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1 *An artist's impression of Neandertal Man (*Homo neanderthalensis*).*
Illustration by Michael Long. Copyright Natural History Museum, London.

2 *A Maasai warrior from Kenya, East Africa.*

3 *An Inuit hunter from NW Greenland.*

The first modern humans had long limbs and narrow bodies. Neanderthals were very different.

environments both biologically and in our behaviour. However, many of the benefits of modern society such as agriculture, transport, and medicine, have changed our relationship with the environment. The link between climate and our own body size is weakening in contemporary society due to population movements and changing patterns of diet and activity. By studying variation among hunter-gatherers and early modern humans, we have the opportunity to learn how environmental and behavioural differences have shaped our anatomy through evolution.

My research looks at how bone strength in human populations is related to climate and physique, rather than simply behavioural differences. I looked at how hunter-gatherers from the cold climates of Siberia or the Tierra del Fuego, on the southernmost tip of South America, were heavier with shorter limbs than hunter-gatherers in warmer climates like southern Africa, the Middle East, or the Andaman Islands, but they also have stronger skeletons. Even if we account for differences in body size between the groups, remaining differences in bone strength still correlate with climate. However, the habitual activity of these populations still has a considerable influence upon their skeletons. Hunter-gatherers that are highly mobile tend to have stronger leg bones than more sedentary groups, and those that use dugouts, canoes or rafts have stronger arm bones than populations that move exclusively on land. Both climate and behaviour have influences on the skeleton, but variation depends on which bones are studied. Climate has its strongest influence on the strength of bones close to the trunk, in other words, the upper arm and leg, while physical activity corresponds with bone strength throughout the body.

If we use this evidence to consider Neanderthals and modern humans, it suggests that much of the strength of the Neanderthal arms and legs may be related to climate and physique, and that differences in the strength of leg bones may not be related to differences in mobility. However, the very strong hand bones, and the asymmetry between the right and left arms of Neanderthals still point to more intense physical activity than modern human populations. By looking at how our own species varies we can directly test the hypotheses about evolutionary and environmental influences on variation. This is essential to our understanding of human evolution and our collective human history.

Jay Stock excavating a 15,000-year-old hunter-gatherer skeleton in northern Jordan.

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