Archaeology

Art of the ancients

Anthony Sinclair

One might imagine that the first examples of art would be simple and crude. New finds bolster the evidence that modern humans were astonishingly quick in developing their artistic skills.

Excavations at the cave site of Hohle Fels in southwestern Germany have unearthed three small animal figurines, as Nicholas Conard reports on page 830 of this issue[1]. The figurines, none longer than 2 cm, were carved out of mammoth ivory sometime between 30,000 and 33,000 years ago by some of the first modern humans to colonize Europe. One is shaped like a bird, another like the head of a horse, and the third seems to be half-man, half-animal.

This find is an important addition to a group of more than 20 ivory figurines that have been found at four sites in the Ach and Lone Valleys: Vogelherd, Geissenklösterle, Hohlenstein-Stadel and Hohle Fels. Without question, they are the oldest body of figurative art in the world — pieces that show a coherent set of manufacturing techniques and themes for representation. Alongside the figurines found at each of these four sites are the remains of waste from ivory, bone and stone working. At these four sites, could we be looking at the oldest artists' workshops?

The study of early art has been plagued by our desire to see this essentially human skill in a progressive evolutionary context: simple artistic expressions should lead to later, more sophisticated creations. We imagine that the first artists worked with a small range of materials and techniques, and produced a limited range of representations of the world around them. As new materials and new techniques were developed, we should see this pattern of evolution in the archaeological record. Yet for many outlets of artistic expression — cave paintings, textiles, ceramics and musical instruments — the evidence increasingly refuses to fit. Instead of a gradual evolution of skills, the first modern humans in Europe were in fact astonishingly precocious artists.

For example, before we were able to date directly the classic cave paintings of southwestern France and Spain, eminent archaeologists had devised evolutionary schemes that ordered the works, from the first charcoal animal drawings to the more recent multicolour animals drawn with a clear sense of perspective at famous sites such as Lascaux and Altamira. And yet the beautiful multicolour horses, lions and mammoths at the Grotte Chauvet in France, discovered in the early 1990s and dating from 32,400 years before present, are now thought to be the oldest examples of cave art in the world (Fig. 1).

The oldest evidence for the use of textiles and clay — at Pavlov and Dolni Vestonice in the Czech Republic and some 26,000 years old — does not suggest crude techniques or a poor knowledge of materials. Among the textiles, there are a number of distinct patterns, and also some finely made clay figurines. Furthermore, the evidence of several thousands of small pieces of ceramic has suggested to some that humans could deliberately manipulate their raw materials to explode ceramics in their kilns on command — perhaps the earliest form of pyrotechnics.

At Geissenklösterle, Germany, a fragment of a bone pipe, of the musical sort, has been found. This pipe was made from the radius bone of a swan and has three clear finger holes. There are also more than twenty specimens of musical pipe of the same sort and age from Isturitz in France. Microscopic examination suggests that they may have been reed-voiced instruments, like a modern oboe, and that the finger holes have been chamfered to increase the pneumatic efficiency of the finger seal: simple whistles they are not. Such evidence of complexity is used to argue that these cannot be the first musical pipes, even though they are the oldest in the archaeological record[2].

All of these finds could still be accommodated in our old evolutionary schemes, if we imagine that the first steps in the discovery and use of these skills were undertaken using more perishable materials; or perhaps earlier examples were simply not discarded in the sites that have been excavated so far. There are examples of unquestionable art before modern humans — such as the engraved stone cortex from the site of Quneitra in Israel, dated to 50,000 years before present — but these can be counted on the fingers of one hand. The argument in favour of fast-developing artistic skills in modern humans is strong, and certainly one that I find convincing.

Returning to Conard's finds at Hohle Fels[1] and those at neighbouring sites in Germany, there is more to challenge our perceptions of the past. These figurines are not 'art' as we know it today — they are personal possessions, and the evidence of very discrete activities. Each figurine shows a series of incised lines, or sometimes crosses, along its back or sides; polishing from constant handling is clear to see[3]. They are found in contexts that suggest they might have been cached for later use, or deliberately buried.

The animal species usually represented — mammoth, bear and lion — are not ones that would have been eaten (a common feature with this early art). The postures of these figurines, and their ears and eyes, reveal a close attention paid to aggressive animal behaviour. They may be material expressions of the shared personal qualities of humans and animals, as is perhaps indicated by the small half-human, half-animal figurine

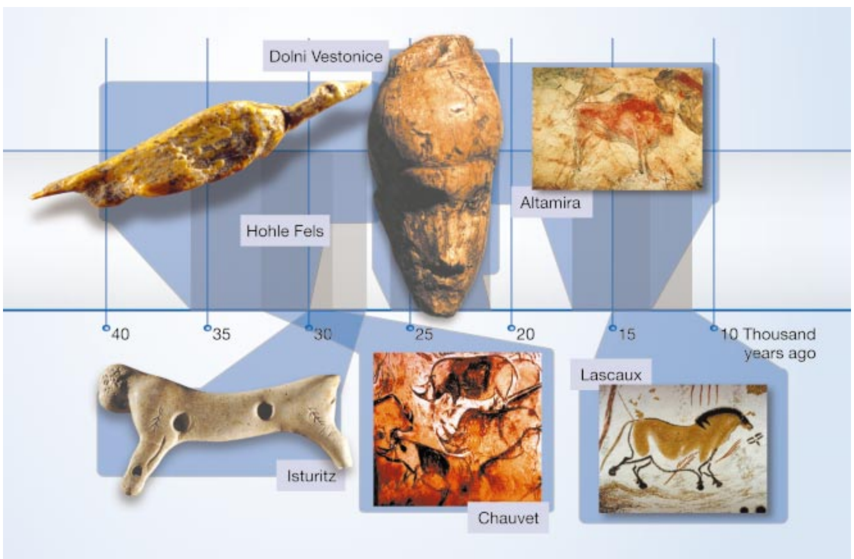

Figure 1 **Prehistoric art. Three figurines from Hohle Fels, Germany[1] — including the bird-like figure shown here — are the oldest examples of figurative art that have been found in Europe. Examples of carving at Isturitz, France, and at Dolni Vestonice in the Czech Republic, and of cave painting at Grotte Chauvet and Lascaux, France, and at Altamira in Spain, show remarkable sophistication. Modern humans seem to have developed artistic skill quickly.**

from Hohle Fels[1], and the larger half-lion, half-human figurine found earlier at Hohlenstein-Stadel. Or they may be expressions of the shared social qualities of single- and group-living species.

The Victorian idea of progressive evolution has been a very persuasive metaphor for explaining change in the archaeological record, particularly over a time of biological change in the human species. Yet the archaeological evidence is now forcing us to come up with new timescales for cultural change and innovation. This is a challenge that makes the smallest finds of archaeology as important as the largest. ■

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Cell biology

Earthworms and lipid couriers

Sean Munro

Lipids can hop between cellular compartments without using the transport vesicles that carry proteins. A key molecule involved in conveying the lipid ceramide has at last been uncovered.

Slice open any eukaryotic cell and you will find it packed with membrane-bounded compartments, each with a characteristic set of resident proteins and lipids. Many of these molecules begin their lives in the endoplasmic reticulum (ER), a large network of intracellular membranes. The process by which newly made proteins are moved from the ER to their final destinations in the cell is well known: they are transported in small containers, or 'vesicles', of membrane that pinch off from the ER and then move to, and fuse with, their target membrane.

Some lipids, however, can bypass this transport process, instead moving directly from the ER to other compartments. The mechanisms involved in this non-vesicular transport are poorly understood, but on page 803 of this issue Hanada and co-workers[1] describe the identification of CERT — a protein that seems to convey the lipid precursor ceramide from the ER to the Golgi apparatus. The parts of CERT that allow it to act as a courier are seen in several families of proteins of unknown function, so the new work also highlights candidates for involvement in other lipid-transport events.

Ceramide is the backbone molecule of the sphingolipids — abundant components of the outer membranes of eukaryotic cells. It is synthesized in the ER, but the addition of headgroups to complete the synthesis of sphingolipids takes place in the Golgi apparatus. Conversion of ceramide into sphingolipids is known to continue when vesicle transport from the ER to the Golgi is blocked[2,3], so ceramide clearly does not rely on vesicles to reach the Golgi. But quite how it is transported has been unclear.

Hanada and colleagues' route to answering this question[1] started with some help from an unusual source: the humble earthworm. This creature's bodily fluid contains a toxic protein known as lysenin, which binds to sphingomyelin — the most abundant of the sphingolipids[4]. Previously, lysenin was used to isolate mutant mammalian cells that are resistant to the toxin because they have less sphingomyelin than usual[5]. Some of these mutant cells have defects in making ceramide. But in one mutant, called LY-A, ceramide is made but its delivery to the Golgi is greatly reduced.

Hanada and co-workers set about identifying the gene that is mutated in these LY-A cells. To do so, they introduced different wild-type genes into the cells until they found one that could restore wild-type levels of sphingomyelin synthesis. They named this gene CERT. To confirm that they had fished out the correct gene, the authors examined CERT from the LY-A mutant cells, and found that, as expected, it carried a mutation — with the result that the amino acid glycine at position 67 of the encoded protein was replaced by glutamate (a replacement symbolized by G67E).

So what role might CERT have in ceramide transport? This proved to be one of those happy occasions when the amino-acid sequence of a newly discovered protein gave a strong clue to how it might act (Fig. 1a). CERT is predicted to be a cytoplasmic protein that contains a START domain — a structural region that in several other proteins forms a deep lipid-binding pocket[6]. In addition, CERT has two motifs known to be involved in subcellular targeting. The first is a pleckstrin homology (PH) domain, which is a member of a family of closely related PH domains that bind to the Golgi apparatus[7]. The second domain is a FFAT motif (comprising two phenylalanine amino acids, 'FF', in an acid tract). This motif is found in several cytoplasmic proteins involved in lipid metabolism, and it binds to VAP, a protein anchored in the ER membrane[8].

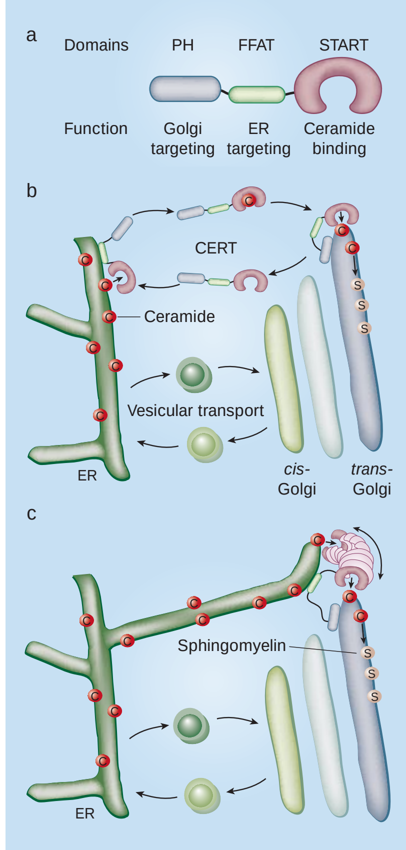

Figure 1 **Conveying ceramide from the endoplasmic reticulum (ER) to the Golgi.** a, **Hanada *et al.*[1] have identified the CERT protein, which contains a PH domain that binds to the Golgi apparatus[7], a FFAT motif that in other proteins binds to the ER protein VAP[8,11], and a START domain that binds ceramide.** b, **CERT might work by extracting ceramide (C) from the ER and then diffusing with it through the cytosol to deliver it to the Golgi. There, ceramide is converted to sphingomyelin (S) by the enzyme sphingomyelin synthase, located on the far (*trans*) side of the Golgi[12].** c, **Alternatively, CERT might bind ER and Golgi membranes simultaneously, allowing the START domain to mediate rapid lipid transfer. Contact sites between the ER and *trans*-Golgi have been observed by electron microscopy[13]. Proteins, meanwhile, are transported between the ER and the near (*cis*) side of the Golgi in vesicles.**

This combination of a lipid-binding domain and targeting domains for both ER and Golgi suggested that CERT acts directly as a ceramide carrier that shuttles between the two organelles. Hanada and colleagues found that CERT's properties are entirely consistent with this model. First, CERT can extract ceramide, but not other lipids, from artificial membranes, and this activity requires the START domain. Second, CERT can catalyse the transfer of ceramide