same results.'[6]

If this is indeed who the Neandertals were, to demand that they should have made tools like those delicate Upper Paleolithic ones in order to prove their full humanity is like demanding that a blacksmith do his work using only dental instruments.

However, among evolutionists, the question still is: 'Were the Neandertals capable of making fully modern (Upper Paleolithic) tools had they desired to do so, or if those tools had fitted their lifestyle?' There are three lines of evidence that would answer that question in the affirmative. These three lines of evidence cover the three areas in which the Neandertals have been so heavily criticized: their minds, their bodies, and their culture.

The Neandertal mind: There must be some significance in the fact that the average cranial capacity of the Neandertals was about 150 cm^3 more than the average for modern humans. In their discussions of the Neandertals, evolutionists often fail to mention that fact. When they do, they discount it, sometimes claiming that the Neandertal brain was not wired in as complex a manner as the modern human brain. In all of the scientific literature, it would be hard to find a more subjective and unprovable statement.

The Neandertal body: In answer to the question of whether or not Neandertals were capable of making fully modern tools, The *Nature* article we have been referring to, 'Manual Dexterity in Neanderthals', is directed to that question. In 1909 the fossil remains of the first of eight Neandertal individuals were discovered in a rock shelter at La Ferrassie in the Dordogne region of southern France. Studying casts of the finger bones and computer simulations of the hands of the individual known as La Ferrassie I, Wesley A. Niewoehner (California State University, San Bernardino) and his associates from North Dakota State University conclude:

> 'As there is no significant difference between Neanderthals and modern humans in the locations of their muscle and ligamentous attachments, there remains no anatomical argument that precludes modern-human-like movement of the thumb and index finger in Neanderthals. The demise of the Neanderthals cannot be attributed to any physical inability to use or manufacture Upper-Palaeolithic-like (Châtelperronian) tools, as the anatomical evidence presented here and the archaeological evidence both indicate that they were capable of manufacturing and handling such implements.'[1]

The archaeological evidence Niewoehner and his associates refer to constitutes the third line of evidence, *culture*. This evidence also indicates that the Neandertals were capable of making modern tools. At Arcy-sur-Cure caves, France, the first evidence of jewellery ornaments of bone, teeth, and ivory have been found in association with Neandertal fossils in the Upper Paleolithic.[7] The importance of this discovery cannot be overemphasized. It will be contested, to be sure. But it is just one of many discoveries that demonstrate that the Neandertals were fully human and were our brave and worthy ancestors.

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How mysterious is the life of a cave?

Emil Silvestru

'Because all scientific ideas depend on experimental and observational information, all scientific knowledge is, in principle, subject to change as new evidence becomes available'[1]

This quote is from the teacher's guide to a PBS (Nova) television documentary entitled *The Mysterious Life of a Cave*. The documentary includes breathtaking pictures of what is considered by many the world's most beautiful cave, Lechuguilla, New Mexico. The spectacular photography is riveting. Although the educational film is designed for grades 5–12, it presents what for many is new observational information—information particularly relevant to the speed of speleogenesis. Certainly some of the traditional ideas about speleogensis, or cave formation, should now be subject to change.

The role of H_2S in cave formation

Focussing on caves in the United States and Mexico, the film explains how it was not solutions infiltrating from the surface of the Earth that carved these caves as asserted in classical speleogenesis. Rather, it was highly acidic solutions rising from underneath the limestone that did the job.

The role of H_2S in speleogenesis has been known for many years. Hypogene caves, that is, caves carved by solutions (mainly hydrothermal) rising from within the Earth (as opposed to caves carved by solutions percolating from the surface), have been previously described in European scientific literature.[2–4] In fact, H_2S and CO_2 in warm to hot aqueous solutions have formed many labyrinth caves worldwide. Some of them are even mined for their valuable mineral resources.[5,6] Cave formation has been reported in even more extreme geological conditions, at temperatures between 200 and 400°C

in the hydrothermal metasomatic post-magmatic phase[7] for example.[8] What is new (but not so 'revolutionary') is the role that the oil deposits underneath the cave have played as a source of H_2S.

Extremophiles

It is of particular interest that microbes can be directly involved in speleogenesis, by eating away limestone. This remarkable discovery was published in the scientific literature in 1969[9] and 1979[10] in Europe.

The PBS film show how, remarkably, the chemicals in the rising hydrothermal solutions provide nutrients for a specialized food chain that is able to survive completely without the need for sunlight. The microorganisms in this food chain play a crucial role in cave formation and are able to thrive in extreme, chemotrophic conditions. *Extremophiles,* as these microbes have been dubbed, seem to be able to survive in almost any imaginable condition on Earth. The first chemotrophic food chain described in a cave was discovered and investigated in 1986, when 32 new species and 2 new genera of invertebrates were described from a cave in south-eastern Romania.[11,12]

Not surprisingly for nature documentaries these days, the film draws a long bow, claiming that *if life is possible in such extreme conditions today, it may well have evolved from similar conditions in the distant past.* Billions of years ago, it is speculated, life may have formed from inorganic matter on the bottom of the ocean, or in cave-like environments under the ground. What the documentary does not mention is that this chemotrophic food chain is based entirely on *pre-existing* bacteria. There is no mechanism whatsoever in these caves that could—even remotely—point to a way in which, in the conditions given, inorganic matter could give rise to organic matter, let alone a living cell!

Significance for creation cave formation models

Some of the discoveries shown in the film are of importance to creationists because the cave formation processes that we can see and measure today are relatively slow. It is not possible to explain how caves could form in some four thousand years after the Flood simply by extrapolating such processes.

An alternative, much more rapid, speleogenic process is required. Hypogene speleogenesis is significant because it provides such an alternative. Speleogenic processes are also significantly accelerated by the presence of sulfuric acid via bacterial activity, and by subsequent microbial carbonate consumption. Microbial speleogenesis can also account for some of the more special minerals found in some caves. The caves in the US and Mexico presented in the film are actually localized examples of what must have been a global karstogenic process.[13]

Although hinted at before,[14] a global karstification model can now be more consistently outlined. After the karst rocks (soluble rocks in which caves are found today such as limestone, dolostone, rock salt, rock gypsum) formed during the Flood, an intense circulation of hot, chemical solutions was set up deep below the surface. These solutions, generically called *hydrothermal solutions* (HTS), had dissolved massive amounts of karst rocks, deep below the surface and were chemically very aggressive. Thus, large mazes of cave passages were created in very short time (possibly during the Flood year, certainly within centuries). If one considers existing calculations about the rate of cave excavation performed in the case of Carlsbad Caverns, the Big Room (in excess of 10^6 m^3) only needed about 10% of the H_2S of the yearly commercial production of neighbouring gas fields.[15]

As the Flood waters receded and the land emerged, the hydrothermal activity diminished and so did cave formation. The once deeply buried cave systems reached closer to the surface while the surface relief carved itself into the sediments. Consequently, large parts of the caves were opened to surface and drained. Some surface streams and rivers that flowed over karst rocks were readily swallowed by caves and, because subterranean drainage was more efficient than surface flow, became permanent underground rivers. They then reshaped the initially hydrothermal caves and, combined with the CO_2-rich seepage waters, gave them the looks so familiar to us today.

Relevance to radioactive dating

Identification of these rapid cave formation processes in the karst systems themselves seriously challenges the sacred cow of radiometric dating which is used for the 'high resolution dating' of speleothems. After the more or less catastrophic draining of HTS from the large karstic voids, substantial amounts of the HTSs were still left in

the extensive network of fissures above them. These HTSs obviously started draining—gravitationally this time—towards the voids and in the process rapidly enlarged the fissure network. This rapid dissolution of limestone was most probably accompanied by rapid deposition of calcite speleothems. The role of these draining HTSs in speleothem formation at this time was almost certainly different from the role that CO_2-rich meteoric water plays in speleothem formation today. This difference would not be confined to the rate of speleothem formation only. No doubt the chemistry of the process as well as the mobility of various ions were significantly different from the ones we can experimentally identify today. This means that there is a serious problem with the very long speleothem ages 'measured' by the $^{234}U/^{230}Th$ method (underlain by the assumption that speleothems always formed the way they form today).

And there is yet another potential challenge to radiometric dating of carbonate formations that this documentary brings forth (though not even hinted at by the scientists involved): if micro organisms eat the limestone, then they also eat the uranium inside it (the very uranium all radiometric dating is based upon). Of what I know, nobody has investigated in what way this might influence the dynamics of this particular element's migration from the limestone to the speleothem calcite. The high-resolution dating of speleothems is entirely based on the belief that we understand this migration in its most intimate detail. I am looking forward to the day the 'microbial correction' of speleothem dating will be introduced!

God's fine sense of humour appears to have provided yet another whole area of prolific investigation which could provide scientific evidence confirming his Word, through the extensive efforts of the ones who do not believe in creation.

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Teeth developing in bird embryos—does it prove evolution?

Don Batten

> 'Birds with teeth turn the clock back 70m years … And they could help to cure baldness.'

So trumpeted *TimesOnline* (UK), 4 June 2003. But, as commonly happens, the title of the actual paper that inspired this statement was much less exciting:

> 'Development of teeth in chick embryos after mouse neural crest transplantations.'[1]

The researchers transplanted the part of a mouse embryo that normally produces teeth into the part of a chick's embryo that produces the head of the bird. They found that the mouse parts continued their development, forming the beginnings of teeth, some surviving up to 18 days.

Using staining techniques with microscopy (histochemistry), the authors demonstrated the activities of various genes considered to be involved in tooth formation, both in the mouse tissue and the surrounding chick tissue. Mouse genes known to be involved in tooth formation were active in the tooth germs (beginning teeth) and certain chick genes were active in the chick tissue surrounding the (mouse) tooth germs.

Significantly, no enamel began to develop on the teeth. The authors argued that the genes active in the chick epithelium were necessary for the mouse tooth germs to develop, but enamel formation needs specific genes present in *mouse* epithelium. This brings into question just how much the chick genes were helping in the tooth development.

One could dispute the researchers' argument for the involvement of any chick genes *specific to teeth* in the development of the teeth. One of the genes in particular, *shh,* is widely expressed during development; it is not peculiar to teeth.[2] Others, such as