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INTO FOCUS

Finding ET

Paleontology may soon enter yet another great episode in its history. The discoveries of the nature of fossils, of dinosaurs, of the oldest life, of Precambrian animals, of saber-toothed cats and woolly mammoths and rhinos have all fascinated people over the centuries. Some of these discoveries have succeeded beyond belief in the movies and on television. Paleontology has always captivated the public in general and the young in particular. So has space science – as much as paleontology. The movies ET and Star Wars have done as well as or even better than Jurassic Park and Lost World for the movie moguls. We discover neat things, and the movie guys make fortunes from such discoveries. Doesn't seem right, but that's the way it works. In fact, those movies are one of "our" major products. Now paleontology and space are set to grab center stage once again through upcoming space missions to Mars and the possibility of future exploration of other targets beyond Mars. What a combination—space and paleontology. It has it all! Expect more movies.

People love ETs, and a huge number believe in them. Sixty percent of Americans, for example, think that aliens are flying UFOs (an acronym highjacked by space freaks to mean an alien space craft). While that figure may be lower in more skeptical societies, everyone seems fascinated by the possibilities. The history is long. For over a hundred years, Mars has provoked images of other civilizations with global canals, huge monuments with human-like faces and ETs usually with pointy heads or chins and big eyes. Once we even thought we were under attack by ETs from Mars, but it was fiction. So were the dead aliens discovered in a supposed UFO crash at Roswell, New Mexico. You would think that if NASA accomplished anything yet with its Mars explorations, it should have put all these fantasies to rest. But it did not—ETs in one form or another are still championed by pseudoscientific writers, commonly accusing NASA or the government of cover-ups. It's hard to sway the believers in any field.

Surely these people will be disappointed by exploration for life in the Solar System. It's been an iffy search so far. Two targets have been identified as strong possibilities: Mars and the Icy Moons of Jupiter (JIM), particularly Europa. Arguments for these as possible abodes of life have been strong, but there is no solid evidence yet whatsoever of any organisms, their traces or their biomarkers. Paleontology may provide that evidence, if life was extirpated on these bodies sometime in the past. We spend a short time living, but an awfully long time dead. It is thus an important discipline in the search for ETs.

Mars, now at its closest to Earth in the last 60,000 years, is attracting much attention. This "Mars mania" focuses in part on the possibility that life will be found there, and the planet's approach offers the opportunity to see it. It is also a wonderful reminder of upcoming exploration efforts. Three spacecraft carrying surface rovers designed to search for life, including fossils, are on their way to the Red Planet. These craft, launched earlier this year, are on flight paths that will encounter Mars and place landers on it next December and January. Soon after landing, the surface explorers will begin their search of the planet's surface with imagers, spectrometers and even a microscope. They won't see a T. rex, an Olenellus, or even a Globigerina, for sure, but a possibility that they may find evidence of past life is there. And how exciting that would be—the first real confirmation that life

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http://palaeo-electronica.org/paleo/toc.htm

Figure 1. Mars Exploration Rover on the surface of the Red Planet, as envisioned by an artist. From http://mars.jpl.nasa.gov/.

once existed on another planet! Fossils from Mars! Paleontology and space!

While past Martian landers provided great data, none found life. The Viking missions of 1976 mixed chemicals with Martian soil to test for life, but got a reaction that most believe was inorganic in origin. Pathfinder and its rover Sojourner, both enormous successes, landed on July 4, 1997, and found a barren landscape with angular boulders of various sizes strewn about with tiny dunes in their wake, but no sign of life—no organisms, no traces. NASA's spacecraft, especially the Mars Global Surveyor (MGS) and its onboard Mars Orbiting Camera (MOC), have revealed Mars to be a hostile, cold, dry world. The MOC images show possible seeps of water, CO2, or merely slumps, and these fan hopes for finding extant life, as does the evidence of water in the polar regions. No evidence suggests that life exists now, and interpretations, if correct, indicate that little liquid water is or was available for it (Bandfield, et al. 2003; Kerr, 2003). The NASA images, however, appear to tell a story of an ancient water-world, where liquid water flowed vigorously over the surface. Of course, other hypotheses have been proposed for these observations as well, and recent evidence reported in Science showing no significant carbonates in the surface rocks suggests that water never had a long-term importance on Mars's surface (Bandfield, et al. 2003; Kerr, 2003). Nevertheless, the evidence for ancient water spawns hypotheses of ancient life, and that cheers a paleontologist. Indeed, the chain of possibilities now includes that we are Martians or at least descended from these early Martian ETs shot into space by a bolide impact that later seeded Earth as the debris found its way there. Ah, the speculations and hypotheses show science at its best and most difficult. Better evidence is needed; and that may be coming.

We've already had one brush with public excitement over Martian paleontology—the meteorite found in Antarctica (ALH-84001) with its putative nannobacteria. Few accept the interpretations that the objects illustrated in that provocative 1996 Science paper are fossils. Instead, they are attributed to terrestrial contamination, artifacts of preparation, or mineral aggregates (see references). The discovery reinvirogated a search for nannobacteria here on Earth, and, lo, they were reported in ancient rocks, modern sediments and human bodies. But the evidence even for these as living organisms is questionable. In the August 2003 Geology, nannobacteria were shown to be the remains of degradation of organic material (Schieber and Arnott, 2003). Thus the Martian meteorite may have picked up organic contamination that degraded while it lay trapped in and on Antarctic ice for millennia forming the questionable fossils.

Many scientists think that life may have evolved on Mars billions of years ago, but that it is extinct now. By comparison to Earth's biota of roughly the same time, Mars may have possessed microbes in its ancient water-world. Presumably these microbes would have inhabited all of the waters of the planet and hopefully left some fossils. Fossils could be found perhaps in the deposits seen in ponds, outflow channels, craters, and other features, as well as possible dead hydrothermal springs and polar ice deposits. Springs of course would have been very likely sites for life when they were active, and if their remnants can be found, would be excellent paleontological targets. The paleontological possibilities seem large.

NASA and the ESA both launched Mars explorers this summer. The US sent two Martian Exploration Rovers (MERs) and the Europeans sent Mars Express Orbiter (MEO). The MERs, known as Spirit and Opportunity, will explore two sites where evidence exists for ancient water on the floor of a crater that has a dry channel entering it and an area covered by hematite which forms most commonly in the presence of water. MEO will take Beagle 2 (you remember Beagle 1, don't you?) to another site that seems to have preserved ancient sedimentary deposits, hence may be a good place for paleontologic prospecting. All three carry cameras and other instruments, but Beagle 2 also has a microscope on board. Beagle 2, using its on-board microscope, will look at rock surfaces cleaned and ground with a grinder, and so may see entirely new evidence missed by previous landers, which examined only the weathered surfaces of rocks. Other missions are planned for Mars later in the decade and beyond that include dedicated science missions and a sample return mission perhaps in 2014. These may well reveal evidence of fossils.

Jupiter's icy moons (JIM) and beyond will be explored by nuclear-powered missions in the more distant future. These Prometheus-class missions will be larger, have far more power and communicate by light rather than radio back to Earth. They will carry bigger payloads and transmit far more data than ever before. The first of these missions, Jupiter's Icy Moons Orbiter (JIMO), will launch in 2011 perhaps, take eight or so years to arrive at Jupiter and a bit more to position itself in orbit sequentially around each of the three icy moons. JIM may be even more exciting paleontologically. A major target is Europa, because evidence now suggests that it possesses a liquid briny ocean below its icy crust. The surface is marked by all kinds of tectonic, impact and volcanic features. Many of these events may have brought life to the surface to be preserved for eternity in the ice where paleontologists can find it. Europan paleontologists will need the basic knowledge they already possess to guide landers successfully to paleontologically rich sites. Paleontologists living today may well not be here by the time these missions produce fruit. Nevertheless, the possibilities are fascinating for all of us.While all this sounds optimistic, what then is the likelihood that extant life or fossils will be found on other planets? Mars will be a critical test. Much of the effort in the search for life is focused on extant life, yet that possibility is not very encouraging. Far more probable, if water did exist at one time on the planet, are fossils. I can imagine that life in the universe was common, but that much of it has gone extinct. This suggests to me that search strategies that optimize the discovery of fossils might be better than those that search for biochemical markers, traces or bodies of living organisms. A good paleontological strategy would likely discover living organisms as well, and paleontologists are usually well equipped to deal with them, although they will surely have dozens of biologists looking over their shoulders at whatever they do.

If any of these missions find life it would be a remarkable discovery and one that paleontology will benefit from enormously. Let's keep our fingers crossed for Spirit, Opportunity and Beagle 2. Many of us can't wait around until 2015, 2020 or even later to find out if fossils exist elsewhere in our Solar System. We want to feel the excitement of one of paleontology's greatest feats ever, sooner rather than later!

ONLINE RESOURCES

Global canals
ltpwww.gsfc.nasa.gov/tharsis/canals.html

Human-like faces
www.msss.com/mars_images/moc/extended_may2001/face/

Attack by ETs
www.war-ofthe-worlds.co.uk/

Surface rovers
www.seds.org/~spider/spider/Mars/mars2003.html

Pathfinder
mpfwww.jpl.nasa.gov/MPF/index1.html

Mars orbiting camera
mars.jpl.nasa.gov/mgs/

MOC images
www.msss.com/mars_images/moc/e7_e12_captioned_rel/index.html

ALH-84001
www-curator.jsc.nasa.gov/curator/antmet/marsmets/alh84001/sample.htm

1996 *Science*
www-curator.jsc.nasa.gov/curator/antmet/mars-mets/SearchForLife/SearchForLife.htm

References
www-curator.jsc.nasa.gov/curator/antmet/mars-mets/alh84001/sample.htm

Fossils
exobiology.nasa.gov/ssx/Selected_Research/exopaleo_ts.html

MERs
mars.jpl.nasa.gov/mer/

MEO
sci.esa.int/science-e/www/area/index.cfm?fareaid=9

Spirit and *Opportunity*
marsoweb.nas.nasa.gov/landingsites/mer2003/doc/finalists_selected.html

Beagle 2
http://www.spaceref.com/news/viewpr.html?pid=3439

Beagle 2
www.beagle2.com/project/index.htm

2014
mars.jpl.nasa.gov/missions/future/2005-plus.html

Prometheus-class missions
spacescience.nasa.gov/missions/prometheus.htm

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