Reaching for the stars: It's alive out there! Scientists seek out the evidence

8 June 2011, By Marc Kaufman

All around the world - from the deep gold mines of South Africa to the far-seeing telescopes in Chile's Atacama Desert, from the frigid glaciers of Antarctica to the halls of the world's best universities and research institutions - scientists are on a quest unlike anything we've seen before. Tens of thousands of researchers are involved in the effort, one which three years of reporting has convinced me will be - or certainly could be - the big idea of our era.

This hidden-in-plain-sight campaign is the renewed scientific push to find signs of life, or of past life, beyond the confines of our planet. The umbrella science that organizes the effort is called astrobiology, and the field is making surprising and compelling progress. It still may well be years before science finds anything that is clearly extraterrestrial life, but scientists are more convinced than ever of the existence of alien life, and they have the newly sophisticated (and still quickly evolving) tools and knowledge to actually find it.

The scientific breakthroughs of the field reflect its breadth: Astrobiology takes in fields ranging from microbiology to chemistry, astronomy and planetary science to cosmology.

From the world of microbiology, for instance, scientists have learned that microbial life is far more tenacious than ever imagined, and able to survive deep underground, in glaciers, alongside hydrothermal vents, and even floating in the atmosphere. From astrochemistry we have learned that all of the elements and molecules needed for life as we know it - hydrogen, oxygen, nitrogen, water, and complex carbons - are present throughout the universe.

These non-living building blocks need planets to land on where they can possibly interact in ways that can lead to biology and life, and now we know that such planets (or exoplanets, are they're called) are common. More than 500 have been positively identified in the past 15 years, 1,200 new candidate planets were discovered by NASA's Kepler mission this year, and astronomers now are convinced there are billions, and maybe hundreds of billions, of exoplanets in the Milky Way and beyond. What's more, techniques for finding exoplanets have evolved to the point that several groups have claimed to have located "Goldilocks" planets - those orbiting their suns at a distance where water won't always be either boiling or freezing.

A new consensus has grown among those who study Mars that the currently dry and very cold planet was once much warmer and wetter - a far more hospitable place for microbial and maybe even more complex life. NASA Mars landers and satellites orbiting the planet have found remnants of river deltas and gullies, as well as ice frozen just below the surface. Perhaps most intriguing, a team under the leadership of NASA's Michael Mumma at the Goddard Space Flight Center has determined that the gas methane spurts out of the Martian surface at regular times and in particular places. This has been painstaking work, requiring 18 years of research using the world's best telescopes and instruments for reading the signatures of elements and compounds.

The great excitement regarding Martian methane flows from this fact: About 90 percent of the methane on Earth is produced by living things. This doesn't mean that the methane on Mars is necessarily also produced through biology, but it sure makes it a real possibility. Mumma's group is continuing its own work, while NASA and the European Space Agency have teamed up to send probes to Mars in 2116 and 2118 with the expressed purpose of trying to understand those methane releases.

In the meantime, NASA is also preparing to launch its most ambitious mission to Mars since Viking, back in the 1970s. The mission, with its

largest and most-sophisticated-ever rover, called Curiosity, is scheduled to launch in the fall and land on Mars in August 2012. While the mission is not designed to specifically search for life, it is meant to look for all the possible components of life and Martian habitats that could support life. The Viking missions came back with equivocal and frustratingly contradictory answers about life on Mars; scientists hope Curiosity will provide a clearer picture.

You might be wondering now why the discovery of microscopic life on Mars, or possibly on the moon Europa or Titan, would be such a big deal. It's complex life, and especially intelligent extraterrestrial life, that gets people excited. One part of the answer involves what we know about the evolution of life on Earth. Of the roughly 3.8 billion years that life is believed to have existed on our planet, scientists say, about 3 billion years featured only those unseen-by-the-human-eye microbes. They ever so gradually evolved into algae and plants and insects and dinosaurs and us, and the same possibility for evolution is expected to exist on some of those distant exoplanets.

But the discovery of Martian microbes that are clearly different from anything on Earth would mean that life started from non-living parts twice in one hardly unique solar system. Given that astronomers now estimate there are something on the order of 10,000,000,000,000,000,000,000 stars in the cosmos and that many will have planets circling them, how likely does it seem that life would begin twice in one solar system, but nowhere else? So a discovery of microbes on Mars would make it highly probable that life is a cosmic commonplace.

If science concludes that's the case, how will we learn more about that biology outside our solar system? The wide-scale presence of the element oxygen or molecule ozone in the atmosphere of an exoplanet would strongly suggest that life is present. That's because the two bond very quickly with other elements and molecules. They would be widely present in their unattached state only if something was producing them in large and consistent amounts. What we know of chemistry says that something would have to be alive.

Then there's SETI, the search for extraterrestrial intelligence. The effort to listen for messages sent from afar has been going on for 50 years, with no apparent success. That has led to some new ideas for establishing contact (optical SETI, which looks for laser-like pulses coming from distant star systems, and METI, the sending out of messages to possibly intelligent creatures or beings). Substantial work has gone into making all these efforts at communication more scientifically sophisticated, but the vastness of the universe makes the task daunting. SETI director Jill Tarter likens the number of stars her team has examined for ET intelligence to a single cup of water taken from the ocean.

With the end of NASA's space shuttle program coming soon, many Americans have complained that the nation's efforts in space are flagging. Nothing could be further from the truth. They're just changing. And with its hard-wired (but little-understood) goal of trying to understand and hunt for life beyond Earth, NASA, the National Science Foundation, and similar agencies around the world are fitfully but with real determination reaching for what just might be the biggest scientific discovery of all time - that biology is not limited to our planet, and may well be widespread throughout the cosmos.

More information: Marc Kaufman is a science writer and editor at The Washington Post, and author of the recently released book "First Contact: Scientific Breakthroughs in the Hunt for Life Beyond Earth," by Simon & Schuster.