Life on Mars?
Evidence for Moisture, Algae, Fungi, and Lichens on the Red Planet?
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Abstract

Background: An examination of 25 photos taken by the NASA Mars’ rovers Curiosity and Opportunity, reveal evidence suggestive of moisture and biology on the Red Planet.

Principle Findings: In several photos the rover’s metal wheels are caked with clumps of Martian soil which indicates the presence of moisture thereby making adhesion possible, whereas the interior of the wheel wells are caked with ice and what could be fungi. In four photos of the same two areas of the Martian surface, white-colored specimens resembling fungi and lichens increase dramatically in size over the course of 12 to 13 days, and what appears to be paraphyses can be discerned. In two other photos of a different region of Mars taken 78 days apart, growth of what appears to be fungi and fungal thread-like hyphae also increase in size and extent. Additional photos taken at various times in different locations reveals the presence of additional specimens resembling algae, lichen, mushroom-like fruiting bodies and fungal mycelium.

Conclusions: If these are living organisms, or, in some instances fossils or the consequence of forces which sculpted the surface of Mars in patterns which resemble biological organisms is unknown. However, life is resilient and adaptive and has been discovered thriving in almost every conceivable environment on Earth. It should not be surprising if there is evidence suggestive of life on Mars.

Key Words: Mars, Life, NASA, Rover, Water, Algae, Fungi, Lichens

Introduction

Presented here are pictorial evidence, 25 photos from two NASA Mars rover missions, which raise a legitimate “either or question” about the existence of biological activity and life on Mars. The evidence favors biology, as some of these specimens have increased in size over periods ranging from 12 to 78 Martian days. It is unknown if these are all living organisms, or in some instances fossils or the consequence of forces which sculpted the surface of Mars in patterns which resemble biological organisms. However, life, as we know it, is resilient and has been discovered thriving in almost every conceivable environment on Earth, from the bottom of the ocean, in boiling hot springs, and in pools of
radioactive waste (Anitori 2012; Moseley & Setlow 1968; Rothschild & Mancinelli 2001; van Wolferen et al. 2013). Microbial life can even survive in space ((Horneck et al. 1994, 2002; Nicholson et al. 2000) and in Martian-like environments (Osman et al. 2008). There is no legitimate scientific reason to suspect that microbial life could not adapt to the prevailing conditions of Mars.

In 1976, the Viking Release experiments provided contradictory findings of biological activity on Mars and which are still being debated (Bianciardi, et al. 2012; Levin 1976a,b). Beginning in 1996, David McKay and his team (McKay et al. 1996, 2008) published a series of articles reporting considerable evidence of biological activity in three meteors from Mars; also considered controversial. Then there are microscopic and macroscopic similarities between structures on Mars and terrestrial stromatolites and incapsulated colonies of terrestrial cyanobacteria (Rizzo & Cantasano, 2009, 2011). These findings are now supplemented by pictorial evidence of numerous specimens on Mars including those which increased significantly in size in just 12 to 13 Martian days (Figures 4-7), and photographs of of what appears to be clumps of moist Martian soil stuck to the rover wheels, and ice within the rover wheel wells which means water is available on Mars to germinate spores and maintain life (Figures 1-3).

As presented in this article, specimens which resemble fungus, algae, or lichens have been photographed A) within the wheel wells of the rover, B) on top of and within rocks photographed by the rovers Curiosity and Opportunity, C) inside concave depressions within Martian rocky outcrops, D) on the ground and connected by thread-like branches in patterns similar to mycelium and mycorrhizal fungus, E) and sporing, germinating and casting bulbous shadows upon the ground beneath them, G) multiplying several times in size as shown in Sol 173 and Sol 186 which were taken 13 Martian days apart, and H) increasing in size from what appears to be a germinating spore and fruiting body as seen in miniature in Sol 3528, and 12 Martian days later (Sol 3540) dramatically larger in size, and I) increasing in the size of what appears to be thread like hyphae over a period of 78 days (Sol 192 vs Sol 270).

Unfortunately the precise identification of these specimens can not be directly addressed at present for the following reasons: A) NASA has never asked the “either or” question, assuming instead that everything encountered on the surface of the Red Planet must be a Martian rock, clay, sand, pieces of the rover, or a “meteor.” B) NASA failed to take close-up or in focus photos of many of the anomalous life-like specimens encountered. C) Important photos, including of the rover wheel wells and especially the specimen this author has previously identified and referred to as “Sol 3540” (Joseph 2014) are marred by unexplained artifacts or are inexplicably blurred thereby obscuring details. And lastly D) numerous photos taken as part of a series are missing from the NASA rover websites.
Yet even despite these conundrums, the pictorial evidence provided by NASA lends great credence to the “either or” question, “is it biology or is it not?” We will now directly address this question, beginning with evidence for the presence of water on Mars.

**Martian Mud, Water, and Ice**

*Figure 1: Sol 529, Martian soil can be clearly seen adhering to the metal wheels of the rover in great clumps, and this would only be possible if the wheel or the soil were moist. What is probably ice, or less likely, fungus, can be seen inside the wheel well.*
Figure 2: Sol 529, Martian ice (or less likely fungi) adhering to the inner metal wheel well of the rover. Areas where Martian soil has washed away from the wheel well can also be seen.
Life, including fungi, lichens, and algae, require moisture in order to fruit and germinate. There is ample pictorial evidence that Mars was once lush with flowing rivers and oceans; but more importantly, an examination of the rover Curiosity’s wheels provides evidence that it drove through moist clay and sand which stuck in great clumps upon the wheels (Figure 1). This clumping adhesion would have been possible only if the soil or the rover’s wheels were moist. In addition, there is extensive evidence of ice frozen within the wheels wells of the rover, as well as what might be fungus (Figures 2, 3). Given that these pictures were taken days and weeks apart and despite the fact that the rover wheels are designed to allow debris to be discarded; this can only mean that what appears to be ice and perhaps fungus was adhering to the wheel wells.

![Figure 3: Sol 472, Martian ice or fungus adhering to the inner metal wheel wells.](image)

Because clumps of Martian soil and ice can be clearly seen attached to the wheels of the rovers it thus appears that Mars is a moist wet planet. In fact, rover Curiosity found 2-4% moisture in Martian soil samples. If spores were to come in contact with moisture, they would germinate; and this supports evidence that fungi, lichens, and algae may be flourishing on Mars.
Evidence For Martian Life

**Sol 3528 and 3540:** On January 16, 2014, NASA released and published low resolution, slightly out-of-focus photos taken of a bowl-shaped structure by the Mars’ rover Opportunity on Mars’ day Sol 3540, at a distance of 8 to 10 feet from the rover. The structure was sitting on a Martian outcrop and was described by NASA in a press conference and press release as resembling a “jelly donut.” According to NASA the structure was not sitting on the same outcrop 12 Martian days earlier on Mars’ day Sol 3528 the last time the rover had taken pictures of that outcrop. That turned out to be untrue as NASA failed to examine photos taken on Sol 3528, whereas when examined by this scientist a “donut shaped” specimen in miniature was visible upon magnification and appears to have just germinated (Joseph 2014), as depicted in Figure 4.

![Image of Sol 3528](image)

*Figure 4: Sol 3528, 500% magnification of rocky outcrop reveals a “donut shaped” specimen, in miniature, in the exact same spot and location as where the larger structure appeared 12 Martian days later. The specimen appears to be a germinating fruiting body.*
Figure 5: Sol 3540, 200% magnification of the specimen reveals the presence of what appears to be spore-producing paraphyses. This specimen appeared in the same exact spot and location as the specimen depicted in Sol 3520, from 12 Martian days earlier.

In statements issued to the media on or about January 16, 2014, NASA and Mars’ rover project scientists stated this specimen was “unlike anything we have ever seen before” and that they were “completely confused” and had no idea what the structure depicted in Sol 3540 was or how it got there. The possibility it was biological never occurred to the rover team. Initially, on January 16, 2014, they reported that composition has "too much sulfur, magnesium and manganese" and which was so distinctly different from other Martian rocks and soil samples that it could not be a
rock, but instead was a meteor which some how appeared out of Martian thin air and came to occupy that slab of Martian real estate. NASA then reversed itself and stated that it is a “rock” “deep red in color” and that “it may have been flipped upside down when a wheel dislodged it, providing an unusual circumstance for examining the underside of a Martian rock.” On or about 2/14/14 NASA displayed photos taken approximately a dozen feet distant from the rover of some broken rocks and proclaimed “the mystery has been solved” and that Sol 3540 was from these broken rocks. Yet, NASA did not determine if these broken rocks also had "too much sulfur, magnesium and manganese." And this means, NASA is just guessing. In fact an examination of all photos and the areas surrounding this specimen does not support NASA’s rock interpretation. There is no debris field or any evidence of displacement of Martian rocks or soil leading from the broken rock pile which would be expected had this specimen rolled or bounced across the Martian surface before settling into place. Further, a magnification of Sol 3540, despite the inexplicable artifacts and blurring which obscures details, reveals the presence of what appears to be spore producing paraphyses (Figure 5); and, as noted a “donut shaped” structure in miniature was already present 12 Martian days earlier (Figure 4).

Unfortunately, despite the controversy surround this specimen, NASA has released only out-focus photos taken at a distance, whereas even recent microscopic photos are out-of-focus.

**Sol 173 and 186.** On Mars day Sol 173, the rover Curiosity took a single photo of at least 6 different specimens white in color and varying in size attached to, alongside and beneath a Martian rock (Figure 6). These specimens resemble lichens and the largest of which has a bowl-shaped appearance reminiscent of the specimen depicted in Sol 3540 (Figure 5). Thirteen days later, on Mars day Sol 186, the rover Curiosity took another photo of this rock from the same angle but at a greater distance. However, instead of 6 different specimens, the three clinging to the side of the Martian rock had grown considerably in size (Figures 7 and 8). These specimens resemble eukaryotic fungi. Hence, it is legitimate to again ask the “either or” question. If it is not biological, what else could explain the increase in size? The evidence supports an interpretation of life.
Figure 6: Sol 173. At last six separate white specimens can be viewed.

Figure 7: Sol 186. Thirteen days later, the specimens have increased in size.
Figure 8: Comparison of Sol 173 and Sol 186 thirteen days later

**Sol 181, 192, 270.** On Sol 192, the Mars rover Curiosity took photos of the Martian soil beneath the rover. As can be seen in Figures 9, 10, 11, 13, Martian soil and rocks are covered with a greenish dusty layer which resemble algae. Criss crossing the ground are small mushroom-like structures and white branching threads which resemble the hyphae and mycelium of fungi.

Figure 9: Sol 192. Specimens resembling Algae and fungal mycelium beneath the rover.
Figure 10: Sol 192. Specimens resembling Algae, mushrooms, and fungal mycelium.
Figure 11: Sol 192. Specimens resembling fungal mycelium growing up and over rocks.

Figure 12: Fungal hyphae mycelium on Earth. In comparing Figures 11, 12 and 13, differences can be attributed to asymmetries in the abundance of water, sunlight, etc.
Figure 13: Sol 181. Specimens resembling fungal mycelium.

Figure 14: Fungal hyphae mycelium on Earth exposed to copious amounts of water.
Figure 15: A comparison of Sol 192 and Sol 270, which were photographed by the rover Curiosity 78 days apart, shows evidence of growth of what appears to be fungal hyphae mycelium and fruiting bodies. Growth is most evident when comparing the upper regions of the two photographs.
Figure 16: A comparison of Sol 192 and Sol 270, which were photographed by the rover Curiosity 78 days apart, shows evidence of growth of fungal hyphae mycelium and fruiting bodies, which is most evident when comparing the lower regions of the two photographs.

On Earth, fungal spores germinate into a mass of branching, thread-like hyphae which can develop into a mycelium which may form fruiting bodies and colonies. Likewise, an examination of Sol 181 and 192, taken by the rover Curiosity depicts the presence of thread-like branches some of which connect with larger white-colored specimens which are rounder in shape (Figures 9-11, 13) and which resemble algae, and mycelium and mycorrhizal fungi. Although it could also be argued that these putative biological specimens do not look exactly like their
Earthly counterparts, particularly in regard to growth and extent, we must remember that if they are Martian life forms, then they have evolved and are growing in an alien environment under conditions of reduced sunlight and relatively little moisture.

An examination of photographs taken of the same areas of Mars 78 days apart, by the rover Curiosity, Figures 15 and 16, also shows clear evidence that these specimens are growing. Growth is apparent in the thickness of and extent of the thread-like hyphae and with increases in the size of what appears to be mycelium. The evidence of growth is a characteristic of living organisms. The evidence favors life.

**Sol 37.** The Mars rover Opportunity took several pictures on Sol 37 which reveal vast fields of miniature ball-shaped specimens which resemble lichens and fruiting bodies.

*Figure 17 (above): Sol 37. Vast fields of miniature ball-shaped specimens.*
Figure 18: Sol 37. Specimens resembling fruiting bodies with thread-like mycelium

Figure 19 (Above): Lichen fruiting bodies on Earth
Figure 20: Sol 37. Specimens resembling fruiting bodies with thread-like mycelium.

Figure 21 (Above): Lichen fruiting bodies on Earth

The specimens depicted in Figures 18 and 20 resemble lichen fruiting bodies. On Earth,
Lichens are a composite organism consisting of algae and fungus. The question is: if these specimens are not biological, then what else can they be? The evidence favors life.

**Sol 304, 305.** The Mars rover Curiosity took several dozen photos on Mars days 304, 305, of specimens attached to crevices or small rocks (Figures 22-23). Like Sol 173, 186, these specimens resemble fungi. Fungi are eukaryotic organisms that includes microorganisms such as yeasts and molds and include an estimated 3 to 5 million species (Blackwell 2011). If these are Martian eukaryotes they may represent yet another unique species of eukaryotic fungi.

*Figure 22 (Above): Sol 305, specimens resembling fungi and algae covered rocks*
Figure 23: Sol 305, specimens resembling fungi and green algae covered rocks
Figure 24: Sol 304, numerous specimens resembling fungi (see also Figure 25 below).
Figure 25 (Above): Sol 304, specimen resembling fungi

Figure 26 (Above): Fungi on Earth
Figure 27: Sol 304. Specimen resembling lichen or fungi with thread-like mycelium.
**Discussion**

Give the versatility and adaptability of life which can flourish under boiling, toxic, frigid, poisonous, and radioactive environments (Anitori 2012; Moseley & Setlow 1968; van Wolferen et al. 2013), the results from the original Viking experiments (Levin 1996a,b), and the detection of biological activity in three Martian meteorites (McKay et al. 1996, 2009), it should not be surprising there is evidence suggestive of life, or past life on Mars as depicted in the pictures presented here. Rather, it should be surprising if Mars was devoid of life.

Given this evidence, coupled with the presence of ice and moist Martian soil on the rover wheels and wheel wells it is thus reasonable to ask: “If its not biological, what is it? To argue in the absence of evidence that the specimens depicted here “may” be mineral deposits, meteors, or some other non-biological substance, is not sufficient to defeat the greater likelihood they are biological. The argument favoring biology is particularly pronounced when examining Figures 16 and 18 as the specimens clearly resemble mushrooming sporing bodies. In Figure 21 the rocks are covered with a green substance which in all likelihood is algae which has also grown up and upon the white colored specimen at the center of the photo. Then there are the before and after photos of Sol 3528 and 3540 taken 12 days apart (Figures 4,5), and Sol 173 and 186 taken 13 days apart (Figures 6,7,8) and Sol 192 and Sol 270 taken 72 days apart (Figures 15,16) all of which show increases in gross size or in the growth, thickness and extent of thread-like hyphae.

The specimen depicted in Sol 3540 (Figures 5) has been labeled a “rock” or a “meteor” by NASA whereas it is this author’s impression it resembles a lichen similar to apothecium which like other lichens is a composite organism consisting of fungi and cyanobacteria; a suspicion supported by an examination of Sol 3528 which reveals this specimen in miniature (Figures 4, 34). Therefore, it was already present 12 Martian days earlier. By contrast, rocks and meteors do not grow in size nor can they move about on their own volition. On or about 2/14/14 NASA displayed photos of some broken rocks and proclaimed that Sol 3540 was from these broken rocks. Yet, NASA did not determine if they also had “too much sulfur, magnesium and manganese.”

If a bowl-shaped rock had somehow became dislodged from this broken rock pile there
would be some evidence on the ground of its acceleration and deceleration including
displacement of other rocks and stones as well as evidence on the ground of its bouncing and/or
rolling to a stop and there is none. Further, in the NASA press release it was admitted, without
explanation, that the structure had "too much sulfur, magnesium and manganese" and thus could
not be a Martian rock. Occam’s razor favors biology.

It is also noteworthy that according to NASA the interior of the specimen is “deep red in
color” which is typical of apothecia, and that the specimen is sitting on its narrower base
supporting the larger bowl shaped portion of its structure, which would be normal for apothecia
but very “unusual” for a rock which had been kicked into that location; which is why NASA
made mention of the “unusual circumstance” of its position on its axis.

Although it could also be argued that these putative biological specimens do not look
exactly like their Earthly counterparts, we must remember that conditions for life on Earth vs
Mars are asymmetric. If they are Martian life forms, then they evolved and are growing in an
alien environment under conditions of reduced sunlight and relatively little moisture. Moreover,
many of the specimens presented here may be long dead and fossilized. On the other hand, they
may be the consequence of forces which sculpted the surface of Mars in patterns which resemble
biological organisms. However, life is resilient and adaptive and has been discovered flourishing
in almost every conceivable environment on Earth. It should not be surprising if there is evidence
suggestive of life on Mars.
Figures 28 Sol 173 (above), and Figure 29 Earthly fungi (below).
Figures 30: Sol 186 (above).

Figure 31: Earthly fungi (above).
Figure 32. Sol 305. Green algae (cyanobacteria) and fungi on Mars?

Figure 33. Algae on Earth
Figure 34: The “before” picture with specimen circled in red, and enlargement inset top.
Implications

The evidence presented here, does not prove but certainly increases the probability that fungi, algae, and lichens are or were flourishing on Mars. If so, the implications are profound.

On Earth, cyanobacteria have played a major role in the terraforming of Earth, having pumped out oxygen as a waste product which in turn contributed to the production of ozone, thereby making it possible for oxygen breathing species to emerge from beneath the soil and the sea (Joseph 2009a,b, 2010). Cyanobacteria also produced tremendous amounts of calcium which serves to glue together their mats, and upon dissolving these mats flooded the oceans with calcium thereby making it possible for bones and brains to evolve (Joseph 2009a,b).

If cyanobacteria and fungal eukaryotes are in fact thriving on Mars, then it can be predicted that cyanobacteria and eukaryotes may be flourishing on every Mars-like and Earth-like planet in this galaxy. If true this would mean that innumerable Earth-like planets may have also been terraformed by cyanobacteria and other microbial denizens dwelling on those worlds, giving rise to oxygen breathing creatures with bones and brains who emerged from the sea, crawling, walking, and with some species eventually standing upright on two legs. And it can be predicted that over the course of evolution on these alien planets, that those with bones and brains grew increasingly curious and intelligent and began pondering their own origins and the nature of existence, and that on at least some of these aliens worlds they may have turned their eyes to the heavens, seeking answers to that primordial question: Are we alone?

Acknowledgements: The author wishes to thank Drs. Gil Levin, Barry Di Gregorio, and Harry Rabb, and the U.C. Berkeley reviewer who prefers to remain anonymous, for their helpful comments, insight, and input.

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Submitted: February 10, 2014
Accepted February 17, 2014
REFERENCES


