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Amelia Carolina Sparavigna *(Department of Applied Science and Technology, Politecnico di Torino)*

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Abstract

Large-scale patterns can arise in the vegetation of homogeneous areas due to biotic interactions of animals and plants. If the satellite imagery has a high enough resolution, such patterns can be easily observed. Here we show some large polka-dot arrangements, probably created by the red harvester ants, in Arizona, near the Grand Canyon.

Patterned Vegetation Created by Ants and Observed in Satellite Images of Arizona

Amelia Carolina Sparavigna

Department of Applied Science and Technology, Politecnico di Torino, Torino, Italy

Abstract: Large-scale patterns can arise in the vegetation of homogeneous areas due to biotic interactions of animals and plants. If the satellite imagery has a high enough resolution, such patterns can be easily observed. Here we show some large "polka-dot" arrangements, probably created by the red harvester ants, in Arizona, near the Grand Canyon.

Keywords: Patterned Vegetation, Ecosystems, Satellite images, Google Earth.

It seems difficult to imagine that, from satellites, it is possible to investigate some aspects of the life of insects. However, it is so. Of course, we are not considering a single small organism, but the colonies that insects can create, such as those of ants and their nests. For instance, the red harvester ants create nests that, with their surrounding area can reach a dimension which is possible to be observed in satellite images having a high enough resolution. Moreover, these nests are not isolated; each one can be surrounded by several other nests, giving rise to a patterned local vegetation, which is visible from above, much better than from the ground. In this article, we will show some patterns, visible in the Google Earth images of an area 10 km long in a valley of Arizona, near the Vulcan's Throne of Grand Canyon.

In fact, the use of satellites for monitoring ant colonies is not a new idea. In [1], it was proposed for supporting natural resource managers that were interested in locating red harvester ant mounds. These ants can have a negative impact due to heavy infestations on pastures. However, they are also important for the survival of other animals, such as lizards. In [1], the researchers evaluated the QuickBird imagery as a tool for detecting the ant mounds. The research gave the result that natural resource managers can use this imagery to determine the severity of infestations. Besides QuickBird imagery, the satellite images of Google Earth have also been used for the "fairy circles" of Namibia [2,3].

As discussed in [4], large-scale regular spatial patterns can arise within homogeneous landscapes from local biotic interactions alone [5-7], that is, the organisms in nature can scale up to produce quasi-regular patterns across large landscapes. Therefore, due to the recent satellite imagery of high resolution, such patterns have been increasingly reported in the ecological literature [4]. For instance, it is possible to observe, in semi-arid East Africa, the mounds built by Odontotermes termites frequently occurring in uniform "polka-dot" arrangements [4].

Polka-dots arrangements can be observed in satellite images also for the nests of red harvester ants. The nests are visible for the following reasons. They are characterized by a lack of plant growth and small pebbles surrounding the entrance of them. Hulls of seeds may be found scattered around the nest. As explained in [8], "in grassland areas, such as ranches, the lack of plant life makes red harvester ant colonies very easy to spot, and where they are very plentiful they may make serious inroads into the grazing available to livestock". The mound corresponding to the nest are typically flat and broad, 300 to 1,200 mm in diameter [8]. Even larger bare areas, on the order of 10 m^2, are created. Trails typically lead away from the mound, like "arms". These trails are used by ants to collect and bring food back to the mound.

In [9], the nest and the related bare areas are defined as nest discs. Alexander Wild, in his web article [9], is showing some examples of how they appear in images. One image from Google Earth is concerning an area South of Tucson, Arizona (31°38.097′ N, 111°03.797′ W). The area is showing a pattern of evenly-spaced "polka-dots" [9]: the dots are the "nest discs of one of our most conspicuous insects in the Sonoran desert, the red harvester ant Pogonomyrmex barbatus. Down on the ground it is harder to get a sense of the even spacing of the nests, but the discs are plenty obvious. The ants keep the large area around their nest entrance free of

vegetation and other unwanted debris" [9].

Reference 9 is fundamental to understand the patterned vegetation that we can find in another area of Arizona. It is near the Vulcan's Throne, a cinder cone volcano and a prominent landmark on the North Rim of the Grand Canyon. This area is not reported in [9], probably because in 2008 the satellite images had a low resolution. Today, using Google Earth for the areas marked in the map shown in the Figure 1, we can see a large landscape covered by discs, that look like those shown in Ref.9. For this reason, we are here proposing that these discs are nest discs of ant colonies. The number of these discs, disseminated in a valley 10 km long is impressing.



Figure 1: The markers show a large area, 10 km long, near the Grand Canyon, where it is possible to observe a patterned vegetation, like that given in the following Figure 2.



Figure 2: Patterned vegetation having a "polka-dot" arrangement (Courtesy Google Earth, coordinates: 36°17'16.79'' N, 113° 05' 57.66'' W). A part of the image has contrast and brightness enhanced.

In the Figure 1, the markers are showing a large area, near the Grand Canyon rim, where, using Google Earth, we can see a patterned vegetation like that given in the Figure 2. The patterned vegetation has a "polka-dot" arrangement of discs. In the following Figure 3 and 4, the pattern is given in images with smaller scales.



Figure 3: Patterned vegetation having a "polka-dot" arrangement (Courtesy Google Earth, coordinates: 36°15'19.18'' N, 113° 04' 55.38'' W).



Figure 4: Discs in patterned vegetation (Courtesy Google Earth, coordinates: 36°14'55.07'' N, 113°05'05.22'' W).

Of course, question could arise about the cause of such discs. If we compare the discs in the Figure 4, with a red harvester ant nest sketched in Ref.10, it seems that they are in fact the nests of these ants. However, since the dryland ecosystems can exhibit patterns of vegetation created by the competition between individual plants [11], a local investigation is required. However, in any case, due to the irregularity of the polka-dot pattern, I would like to exclude an unnatural origin.

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[3] In Namibia, some grasslands that develop on deep sandy soils are punctuated by thousands of quasi-circular bare spots, usually surrounded by a ring of taller grass. As told in [2], the causes of these so-called "fairy circles" are unknown, although a number of hypotheses have been proposed.

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