

## ARE THE DARK DUNE SPOTS REMNANTS OF THE CRYPTO-BIOTIC-CRUST OF MARS?

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**Abstract:** We compared analogous sites on Earth to those Martian areas where a peculiar spotting phenomenon [1, 2] on the dark dunes occur. Analogies between Martian and Antarctic desert life conditions were compared long ago by Friedmann [3]. We found possibly candidates to these appearing and disappearing living organisms: those cyanobacteria which form the crypto-biotic-crust in hard terrestrial conditions.

**Terrestrial spots with transient living conditions:** According to Australian analogies (in the "Red Heart" of Australia, between Alice Springs and the Ayer's Rock) the *Crypto-Biotic-Crust (CBC)* regularly occurs and forms continuous, some hundred meter – kilometre sized spots with dark blackish-brown or blackish-violet colour on the temporarily wet depressions between the hills or dunes, where the waters are collecting for a short time. After one-two months of active life period during the limited rainy season the dried CBC waits for the next wet period. Such seasonal changes of the CBC were observed also on Hungarian semidesertic sand dunes [4]. The violet-black colour is given to the surface by the scytonemin pigment of the cyanobacteria which play important role in this crust. This violet-black colour pigment accumulates in the gelatinous sheath of the cyanobacteria and it is protecting the living cell and its pigments for assimilation from the intensive UV radiation, and such way this layer makes the survival of the cells possible. Because the cyanobacteria are capable to survive in extreme cold or heat, and moreover dry conditions, it is probable that they also could survive the hard Martian conditions. Even those cyanobacteria were capable to awake to live which were in frozen state for millions of years in the Siberian permafrost [5]. On the basis of these analogies we may suspect and assume that in the given Martian conditions the dark dune spots are consisting of cyanobacteria or other similar living organisms.

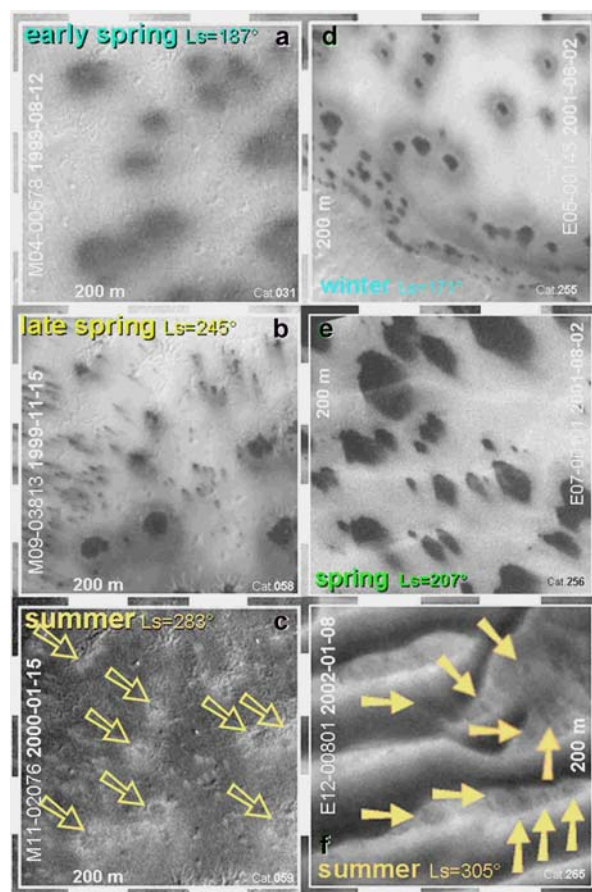
**Martian spots with transient living conditions:** We have named these spots Dark Dune Spots (DDSs) (*Americans informally call them as Dalmatian spots, oriented fans and fried eggs*) and various hypotheses have been put forward for their origin and formation process, which fall into two main groups: geophysical [6, 7 and 8] and biological [2, 10, 11, 12 and 14].

Based on a detailed study of more than 400 MGS NA MOC images of Southern Polar Region of Mars we suggested a kind of biogenic origin of DDSs [2, 12], which is similar in many aspects to the life cycle of the CBC organisms.

**Characteristics of the Dark Dune Spots:** Here we summarize the main characteristics of the DDS phenomenon in order to show the basic similarities to CBC-type behaviour.

The main morphological characteristics of DDSs are [12]: ① diameter varies between a few dozen and a few

hundred meters, ② on the flat areas the majority of the early DDSs are circular (Fig. 1a, 1b, 1d, Fig. 2), ③ circular shapes of DDSs are superimposed on the local small-scale topography, ④ on slopes elongated DDSs develop (Fig. 1e), ⑤ elongation depends on the slope angle (from some spots extensions point downwards), ⑥ seasonal changes (Fig. 1a,b,c and Fig. 1d, 1e, 1f) and ⑦ annual reappearance (Fig. 3a, 3b).



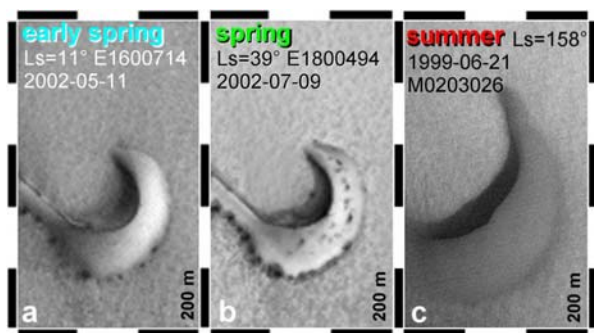
**Fig. 1** Seasonal changes of the DDSs at the same places of the Inca City (295°E, 82°S, a, b, c) and at different places of the Pityusa patera (37°E, 66°S, d, e, f) areas from winter to summer. Arrows indicate lighter grey patches.

We observed [2, 11 and 12], that the DDSs slowly change in shape, extent, and number and reappear in the next year. We found the following time sequence of the morphological changes of DDSs: initially little grey fuzzy spots (or fields of spots) appear (Fig. 1a); the boundary of the grey fuzzy spots gradually becomes sharper and greyer (Fig. 1b, 1d, Fig. 2a, 2b).

Finally the boundary extends, when frost has totally sublimated (summer), lighter grey patches (LGP rings) with

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darker central portion) remain at the site of the DDSs (Fig. 1c, 1f) and in next year (Fig. 3a, 3b) about 70% of DDSs reappear at the same places [13].

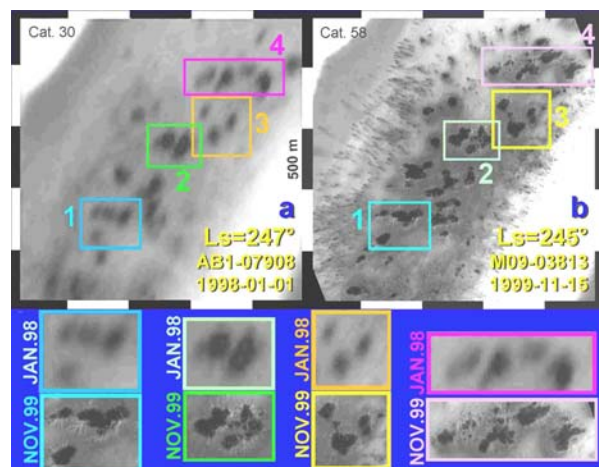


**Fig. 2** On the Northern DDSs we could observe seasonal changes also [14]. Early spring small dark spots (95°E 76°N) appear (a) which grow larger (b) till the end of spring, but in summer no traces of DDSs can be seen on the defrosted dark dunes (c).

#### Discussion: current CBC on Mars?

The fact that extensions originate from some spots indicates some downward seepage or flow, i.e. transport of a fluid phase, which occurs below the frost cover (Fig. 1e).

We interpreted the DDS sequence of changes in the following way. The general radial symmetry, (except some outflow, seepage) and the defrosting beginning from bottom of the frosted layer means that a process begins at the frost-soil surface boundary. DDSs gradually become holes in this process. In the DDS process – grey period – the frosted layer gradually becomes thinner and finally disappears. This may imply that the melting/evaporation process “eats up” the frosted layer. The DDS holes allow the light and atmosphere to make contact with the dark surface at the bottom where the DDS centres develop.



**Fig. 3** The annual reappearance of the DDSs in the Inca City [12] from 1998 (a) to 1999 (b).

**Summary:** We suggested a CBC type terrestrial analogue process as a biological interpretation of the DDS phenomena [2, 12]. In this model we combined the sublimation processes

with some kind of process belonging to cyanobacteria type organisms which constitute the crypto-biotic-crust cover on terrestrial extreme surfaces [15]. If such CBC type crust of extremophiles bacteria exists on Mars (earlier we called them Martian Surface Organisms - MSOs), they could live only below the surface ice, and they could survive the cold and dry (summer, autumn) periods, without the frost cover, in a dried state. When the frost layer is heated up by absorption of sunlight, MSOs produce water from the frost, grow and reproduce through photosynthesis. This way CBC-MSOs can generate their own living conditions (liquid water and water vapour can also contribute to sustain this form of life). Activity of the MSO communities governs the defrosting/melting process on the top of the dark dune surface where the DDSs can be observed.

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