SPECULATIONS ON ADAPTATIONS OF ANY LIFE ON VENUS, PAST TO EXTANT. S.S. Limaye[1], L. Rothschild[2], R. Mogul[3], J. Head[4], and M.J. Way[5], [1]University of Wisconsin (1225 W. Dayton St., Madison WI 53706, USA, sslimaye@wisc.edu), [2]NASA/Ames Research Center (Moffett Field, Mountain View, CA 94035, USA), [3]California State Polytechnic University (3801West Temple Avenue, Pomona, CA 91768, USA), [4]Brown University (324 Brook Street, Providence, RI 02912, USA) [5]NASA/GISS (2880 Broadway, New York, NY 10025, USA).

Introduction: If life arose on Venus or was seeded in its ancient past when it presumably had liquid water on the surface until perhaps about a billion years ago[1-3], it has experienced considerable changes in environmental conditions. Little is known about the conditions on early Venus, but what has been inferred for Earth provides some speculative basis given their physical similarity, proximity to the Sun and past volcanic activity. The key conditions include surface temperature, pressure, atmospheric composition, geochemical make-up, presence of liquid water, global circulation, and the rotation state (rate and axial tilt) which control the day-night cycle over the planet and its atmosphere.

The present rotation states of Venus and Earth are quite different – Earth with a 23.5° axial tilt and a 23.9344696 hour sidereal day and Venus with 177° tilt and a 243.0212 ± 0.0006 day [4] sidereal period. Small variations in this period on short term scales (< 10 years) have been detected [5, 6], likely as a result of the exchange of angular momentum with the atmosphere [7, 8] and larger, long term variations during any evolutionary adaptations over the eons may have occurred for Venus. Thus while the day and night at present are on average 12 hours each for Earth, the backward spin of Venus and an orbital period of 224.7 days results in day and night each about 58.35 Earth days long.

It is not known what the rotation rate of Venus was in the past. Tidal dissipation (solid body or oceanic) [12,19,20,22] and/or core-mantle friction (CMF) [10] can be remarkably efficient at slowing rotation rate, while CMF can also influence obliquity [10]. Investigations into the effect of atmospheric tides on Venus [9-11] suggest that regardless of the initial rotation period, Venus has arrived at the present slow, retrograde rotation state (see [21] for a review). If Earth is any indication, it is possible that the early rotation period of Venus was much shorter, perhaps similar to that of the early Archean Earth (<6 hours [18]) . Earth's rotation period ~1 billion years ago when life originated on Earth was much closer to the present day period, due to the presence of the moon (18-21 hours [18]). Lacking a moon (presumably), the Venus rotation rate could have remained short for a long period until a thick atmosphere evolved.

Any life, if present today, in the potentially habitable zone in the Venus clouds would have undergone numerous adaptations to survive in such environmental conditions, particularly if the current atmosphere is a product of post-tessera volcanic activity [1, 12], or alternatively is a "fossil" atmosphere, dating from the first 80% of the geological history of Venus [13]. It has been speculated [14, 15] that life could have migrated to the clouds and found a permanent habitable niche by the time the surface conditions became inhospitable.

One of these environmental conditions is the duration of the day–night cycle. Since much of Earth's productivity is traced to photosynthesis, such long periods of darkness would have a profound effect on such processes on the Venus surface, creating day/night durations comparable to the polar regions of the Earth In addition, the day-night cycle on Earth is a trigger for the circadian clock among even the primitive unicellular to plants, fungi and animals (including humans) on Earth [16, 17]. Hence the question arises about the impact of a changing circadian clock on Venus.

For the speculated habitat in the clouds of Venus, adaptation to acidity and low water activity is necessary in addition to paucity of nutrients and a changing rotation period. There are terrestrial analogs to such adaptations and it is possible that similar adaptations could have happened on Venus as conditions changed and polyextremophiles survived. Did the day-night cycle duration help this process?

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