Interplanetary exchange in the Solar System – are we really biologically isolated? Margarita Safonova and Chandra Sivaram1,2. 1Indian Institute of Astrophysics, Koramangala, 2nd block, Bangalore 560034, India (margarita.safonova62@gmail.com), 2(profcsvaram@gmail.com).

Following the explosion of humanity’s space exploration, Planetary Protection Policies were introduced in 1950s [1] to restrict the possibility of introducing terrestrial biota to outer space worlds with our spacecraft and probes (termed forward contamination). In addition, they were also intended to regulate the return of samples from outer worlds to safeguard the Earth from possible unfriendly organisms (back contamination). In this regard, the Planetary Protection Policies are purely anthropocentric. In case of forward contamination, the basic concern is that if we bring terrestrial organisms to another world, it would confuse our scientific identification of the indigenous life forms. In the case of back contamination, it is the Earth life that could be under the threat of being extinguished.

This point of view completely ignores the fact that Solar System objects do not exist in isolation. The Solar System is full of dust: remains of asteroids, comets and impact ejecta. Every day 100 to 300 tonnes of this interplanetary dust with particles masses of $10^{-12}$ to 1 g accretes on our planet. Larger meteorites of the size big enough to produce a fireball (10 cm to ~few metres) enter Earth atmosphere at the rate of up to 500,000 annually. The same happens with other planets. Ejecta from large impactors goes to neighbouring planets, for example, roughly a third of impact ejecta from Venus lands on Earth, and about a quarter from all terrestrial planets is reprocessed by Jupiter, with reasonable assumption that some lands on the potentially habitable Jovian moons.

Earth itself is inhabited for the last ~4 billion years. And in all these years it had its share of dramatic impacts, lifting tonnes of rocks, dust and water (with living organisms) into space. Experiments conducted in the last decades in space and on the ground confirmed that microorganisms are able to survive all stages of associated hazards: impact shocks, impact ejections, and interplanetary transfer. Some are capable of doing it even without much of the protection, but most need just centimetres of the protection (e.g. [2]).

The Solar System was formed from the same protoplanetary disk, and findings of complex organics in meteoroids (including amino acids and even a protein – the first extra-terrestrial proto-solar protein, named hemolithin due to the presence of iron and lithium [3]) indicate that life-building blocks were available everywhere from the beginning. Terrestrial planets, some moons and even some asteroids were potentially habitable very early on, with water and protective magnetic fields. The whole Solar System is thus already contaminated by the constant interchange of meteoroids, with their water, organics and possible biota content. Therefore, it follows that it is too late to enforce the Planetary Protection Policies, maybe 4 billion years too late.

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References: