The search for a new Earth and its colonization by microorganisms

Jordi GARCIA LACALLE
Degree in Microbiology, Universitat Autònoma de Barcelona, Bellatera, Spain.

The human species, throughout history has had the urgent need to discover, to browse, to look beyond all the knowledge acquired. So also it dedicated to solving existing problems. This paper will attempt to give an overview of how one of those anticipating future events issues such as human extinction, avoid it. It will be done by finding a new home, a new earth, and how to prepare for our arrival one day only using microorganisms.

INTRODUCTION

65 million years on Earth there was a mass extinction of living things. We live on a planet that used to not having many disasters in our present age, we forget all the dangers that can befall us as a species survival level and cause our extinction. Throughout history, humans have been evolving and growing in knowledge at a scientific level. It has been able to find solution to many complex problems and situations presented to him. It's time as a species and applying this knowledge acquired throughout history, to step forward and be able to anticipate events that can lead to the extinction of our species.

OBJECTIVES

The search for exoplanets

Indirect detection methods [Fig .1]

The planets do not emit visible light, only reflect, so with a star that is too bright will be difficult to see. That's why we have to use indirect detection methods to detect exoplanets. These do not look to detect exoplanet but its effects on its star [1]

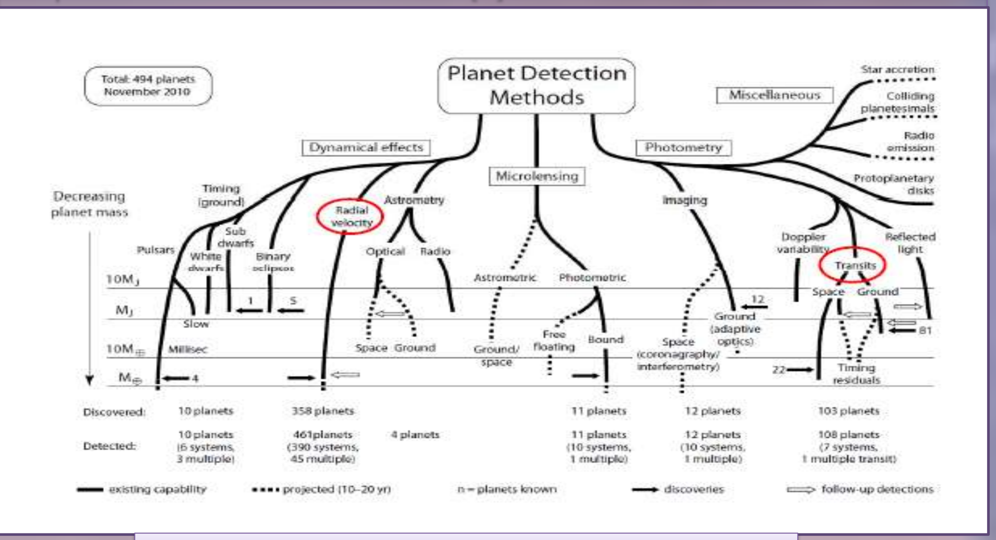

Fig.1 Planet Detection Methods

- Radial velocity [Fig.2] : When a star has a planet orbiting, it is also followed by a small orbit as the center of mass is offset from the center of the star. This variation of the radial velocity is the cause of these movements [2].

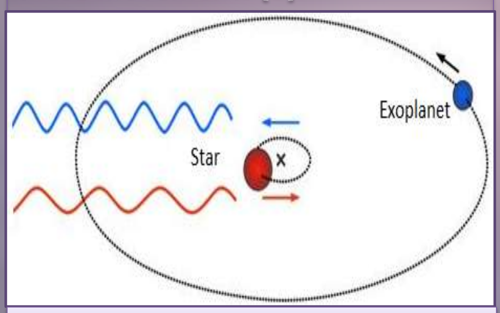

Fig.2 Radial velocity

- Transit planetarium: [Fig 3] When a planet passes in front of a star, the amount of light received decreases, which depend on the size of the planet and the star.

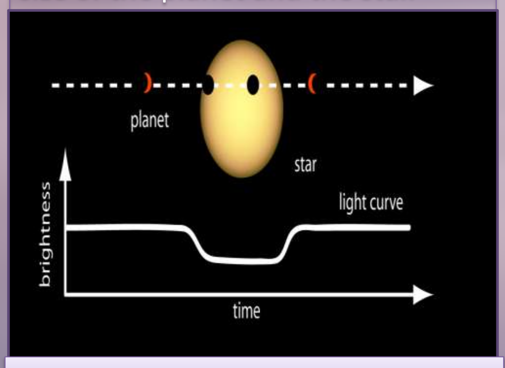

Fig.3 Transit planetarium

Determination habitable zone

The habitable zone is that region between the minimum and maximum distance of a planet and its star for liquid water may have been [3].

Albedo [Fig.4]	Exoplanet mass	Orbit [Fig.5]	Rotation	Type of Star [Fig.6]
The energy reflected from the Earth to the Universe.	The low-mass planets are poor candidates for habitable. The molecules are more likely to reach escape velocity and be lost in space with minimal collision or a simple solar storm. [4]	As larger the eccentricity, the temperature variation is higher.	If there were no tilt on the polar axis, there would be no seasons. Therefore one of the most important dynamics of life could not be present.	Depending on the size of the star and its brightness varies this habitable zone.

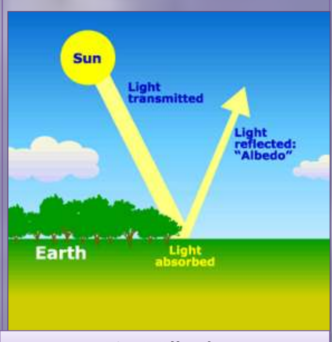

Fig.4 Albedo

Fig.5 Habitable and Non Habitable Orbit

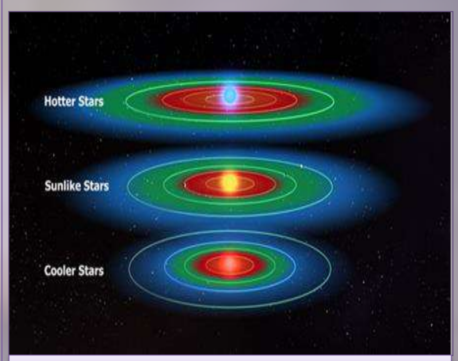

Fig.6 Different types of stars

Determination atmospheric composition

The universe is full of different compounds, some more and some less abundant [Fig .7]. According to some studies based on the digital data of AGW Cameron, the abundance of certain compounds, which are curiously more reactive than exist in nature it is shown. [5]

Visible light is only a small part of the light is what we see with our own eyes [Fig .8]. Beyond the red, have infrared, microwaves and radio waves. On the other side we have the ultraviolet light, X-rays and gamma. This is what we know as electromagnetic spectrum, and the study of this, is what determines us to have compounds present in a planetary atmosphere. [6]

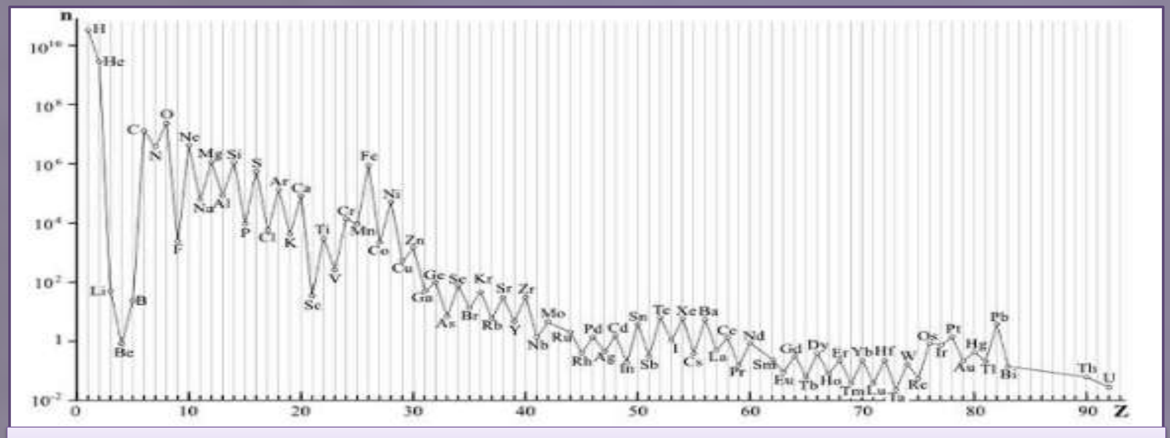

Fig.7Abundance of chemical elements in the universe based on the digital data of AGW Cameron.

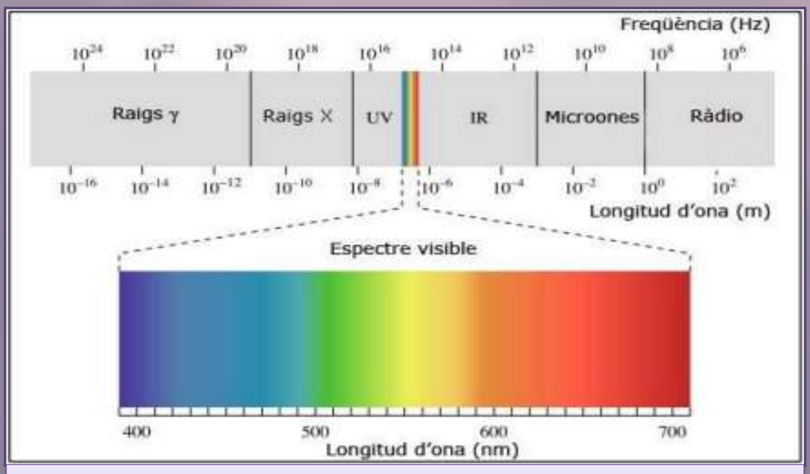

Fig.8 Electromagnetic Spectrum

How to colonize exoplanets

Currently, the planet Earth has an atmosphere about 100 km high, but due to pressure from the gases themselves, we find them all in the first 16 km.

This layer has a mass of $5.1 \cdot 10^{18}$ kg, of which 78% are N_2, 21% O_2, 0.9% Ar and O_3 0.03% CO_2. Meaning that O_2 have this $1{,}071 \cdot 10^{18}$ kg. [7]

Planet to colonize	0% O_2	0 Kg O_2
Current land	21% O_2	$1{,}071 \cdot 10^{18}$ Kg O_2

To make a settlement and get an atmosphere with 21% O_2 as Earth, a study of the earth's global primary production takes place [Fig .9]. This production is produced by different organisms such as diatoms, Chlorophytes, Cyanobacteria and Coccolithophorids. [8-9] Order by level of primary production. [Fig 10]

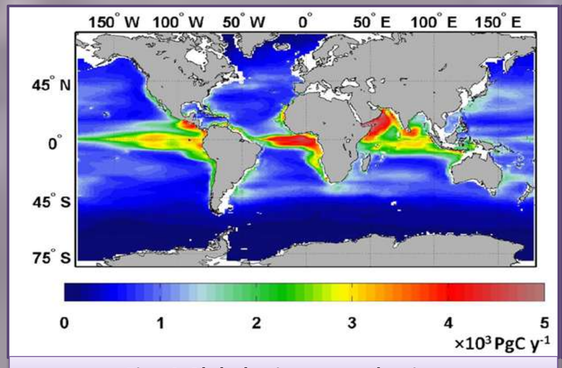

Fig . 9 Global primary production

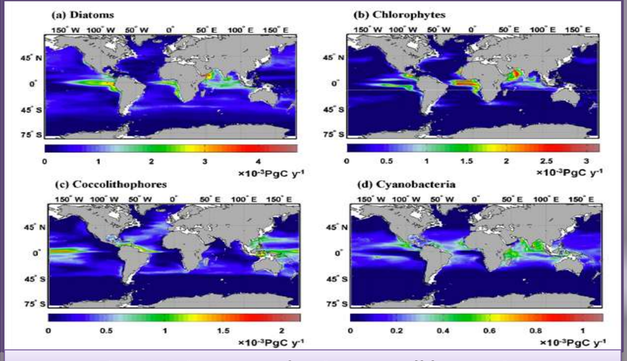

Fig. 10 Primary production overall by species

Colonization will make using the photosynthetic microorganisms. In this case we use cyanobacteria. Cyanobacteria are microorganisms that are found in the first 40 meters deep, with the first 10 meters optimum primary production [Fig 10]. [10]

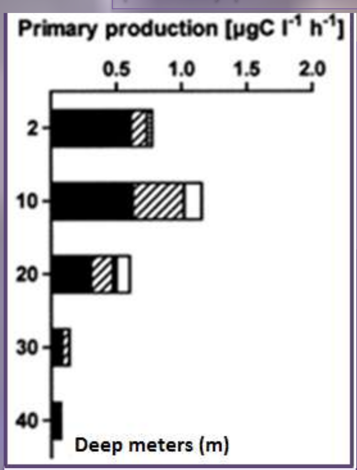

Fig .10 Primary production as deep

To get to do an interpolation in this case ideal scenario, we have to rely on production made by these microorganisms. Thanks to the data provided NOBM during 1998 and 2011, we know a numerical approximation of primary production [Fig. 11]

	Las diatomeas		Clorofitos		Las cianobacterias		Cocolitofóridos		Total
	PgC · año -1	%	PgC · año -1	%	PgC · año -1	%	PgC · año -1	%	PgC · año -1
Océano Austral (SOC)	4.0	89	0.2	5	0.0	0	0.3	7	4.5
Sur de la India (SIND)	1.7	51	0.4	13	0.5	13	0.8	23	3.4
Pacífico Sur (SPAC)	2.2	46	0.6	13	0.6	12	1.4	29	4.7
Atlántico Sur (SATL)	1.2	51	0.4	19	0.2	10	0.5	20	2.3
Indian Ecuatorial (EIND)	1.9	52	1.0	28	0.5	14	0.2	6	3.7
Pacífico Ecuatorial (EPAC)	2.8	43	1.1	16	0.7	10	2.0	31	6.5
Atlántico Ecuatorial (EATL)	1.1	36	1.2	42	0.2	8	0.4	13	2.9
Norte de la India (NIND)	0.7	48	0.6	38	0.2	12	0.0	2	1.5
Norte Pacífico Central (NCPAC)	2.4	51	0.5	10	0.7	14	1.2	25	4.7
Norte Atlántico Centro (NCATL)	0.6	26	0.4	16	0.5	19	0.9	39	2.4
Pacífico Norte (CNAP)	1.1	86	0.1	10	0.0	0	0.1	4	1.3
Atlántico Norte (Natl)	0.6	51	0.2	20	0.0	1	0.3	28	1.1
Global	20.3	52	6.8	17	4.0	10	8.0	21	39.0

Fig .11 Primary oceanic production NOBM during 1998-2011

We note that cyanobacteria are responsible for producing 10% of primary production, which equates to a value of 4 PgC y-1 which corresponds to $1{,}465 \cdot 10^{12}$ Kg annual O_2. With a biomass of $2.16 \cdot 10^{25}$ cells in total as ocean waters are known to be of $3.578 \cdot 10^{8}$ km². If extrapolated, the value will be 6.03 km² $\cdot 10^{7}$cells. [8]

If the annual production of oxygen these microorganisms ($1{,}465 \cdot 10^{12}$ Kg O_2) are known and are known to the amount you want to get ($1{,}071 \cdot 10^{18}$ Kg), making a simple rule of three, find the value in years that would reach that coveted 21% oxygen.

Cyanobacteria would happen if these were in an ideal system, where you have absolute availability of nutrients and preferential geographical location? A study by Robert L. Burnap the Department of Microbiology at the University of Oklahoma, said it would. In the case of not having any competition for nutrients or other aspects listed above. These cyanobacteria, only limited growth would hypothetically intracellular physical barriers by reaching what is known as crowding-limited Intracellular [Fig .12]. [11]

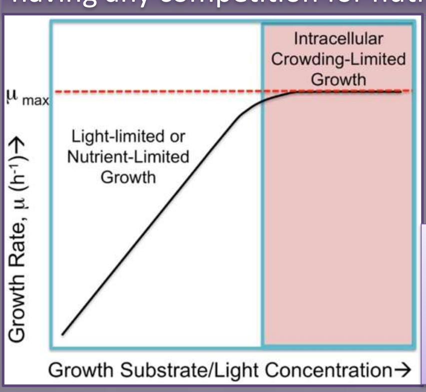

Fig 12. Maximum growth rate of cyanobacteria in the absence of competition for food or light.

That is why, given this hypothetical ideal model, and see growth at the level of biomass of at least 3 orders of magnitude, which will result in a higher oxygen production, worth 1.465 · 1015 Kg annual O2. Reduced value into consideration, the period of time that must pass to get to about 21% oxygen and complete planetary colonization. Keeping in mind that intraspecific competition may occur and then the model would not be met perfectly.

What if there were no water?

Methylomirabilis oxyfera [12] is a microorganism capable of harnessing compounds such as nitric oxide and oxygen and transform to N2 [Fig. 13]. The oxygen produced, much of it is used to hydrolyze the methane producing alcohol and water. Compound is accumulated. Also remove nitrogen compounds as nitric oxide and methane.

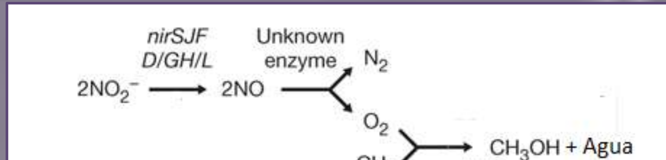

Fig .13 *Methylomirabilis oxyfera* metabolism

Results and Conclusions

- Every day is improving the sensitivity of these techniques, to increasingly refine and find smaller and planets like our Earth. Indirect techniques are currently the most widely used to discover exoplanets.
- Astrobiology and studying the detection and characterization of exoplanets, is a field that still long way to go. It is in a period of time where we have seen just one thousandth of all the knowledge that is acquired.
- The planetary colonization today is to go beyond. It is an imaginative idea, from a theoretical point of view, can be explained, but it is necessary that it can be implemented to reach anticipate everything that can happen as we kind of face to the future.
- In this work the idea of using microorganisms to make only primary production to raise the 0% oxygen in a planet that has not, up to 21% current land is proposed. As we have seen, these are not major producers but still the period of time required to perform such duties is $7.3 \cdot 10^{5}$ years, a value much lower than the $2.2 \cdot 10^{9}$ years it took to the Land to reach that level.
- At the time that the ideal model is assumed, in which cyanobacteria do not have competition for nutrients, and only their own genes are limiting their growth, we obtain the same result in only 730 years.
- There may be many ways to prevent our own extinction, or very few. Everything depends on what we are predisposed to make the change of mentality to avoid something that mankind can not escape forever.
- Methylomirabilis oxyfera It is only a small discovery of all knowledge that remains to be discovered about it.

References

[1] EXOBIOLOGIA O ASTROBIOLOGIA. [Online]. Available: http://www.iac.es/gabinete/difus/ciencia/annia/astrobio.htm. [2] Cursos en Sabadell - AstroSabadell.org. . [Online]. Available: http://www.astrosabadell.org/es/formacio/cursos-a-sabadell. [3] Kasting, J.F. and Catling, D. (2003). [4] Alan P. Boss 2001. Mass Objects [5] Les mystères de l'Univers et les phénomènes astronomiques — Astronoo.com [6] Volkmann, W. (2008). [7] Monson, R. and Baldocchi, D. [8] Rousseaux, C.S., Gregg, W.W., 2014 [9]. Carr, M., (2006). A comparison of global estimates of marine primary production from ocean color. [10] Garcia-Pichel, F., Belnap, J., Neuer, S. and Schanz, F. (2003). Estimates of global cyanobacterial biomass and its distribution. [11] Burnap, R. (2015). [12] Ettwig, Nitrite-driven anaerobic methane oxidation by oxygenic bacteria. Nature, 464(7288), pp.543-548.

Acknowledgements

I would like to acknowledge the help rendered during work my tutor, Dr. Jordi Mas Gordi, for their countless ideas about work, as well as its continuous idea of keeping the work within the reality always opting for demonstrable and realistic values. Secondly I would like to pay special tribute to Dr. Institute of Space Sciences of Catalonia, Ignasi Ribas Canudas for their support to perform work on the subject, which is little known and there really is little research underway and the theoretical support shown for it. And finally, I would like to thank the support given to professionals Astronomical Association of Sabadell in particular astrophysicist Albert Quintana backpack.