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Are the financial resources spent in research in the field of Astrobiology justifiable?

Os recursos financeiros gastos em pesquisas na área de Astrobiologia são justificáveis?

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Abstract

The main idea here is to provide a reflection about, if it is justifiable to spend financial resources on research in the field of Astrobiology? The reason for this article is linked to the growing interest in this research program, not only by the media, but nowadays also by the scientific community through good science. The methodology to develop this work is based on the concatenation of favorable and unfavorable arguments that science practitioners provided, over time, about this research activity. The results suggest that inductive optimists employ the principle of mediocrity as a means of argumentation, aiming to demonstrate that the practice of this research is based on good science and justifiable. On the other hand, the group of skeptical science practitioners challenging this research argue that there is insufficient evidence to justify all the commitment, supply and expenditure of scientists' energy and time, as well as financial resources. Finally, Astrobiology is a science that benefits society by providing knowledge subsidies with significant potential for exploration in pharmacology, the food and agricultural industry, and bioremediation treatment of environments contaminated by oil.
Keywords: Philosophy of Science; Astrobiology; Extremophile; Financial resources.

Resumo

A ideia principal aqui é refletir sobre se é justificável gastar recursos financeiros em pesquisas na área de Astrobiologia? A razão deste artigo está ligada ao crescente interesse por este programa de investigação, não só por parte dos meios de comunicação social, mas hoje também por parte da comunidade científica através da boa ciência. A metodologia para desenvolver este trabalho baseia-se na concatenação de argumentos favoráveis e desfavoráveis que os praticantes da

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ciência forneceram, ao longo do tempo, sobre esta atividade de investigação. Os resultados sugerem que os otimistas indutivos empregam o princípio da mediocridade como meio de argumentação, visando demonstrar que a prática desta pesquisa é baseada em boa ciência e justificável. Por outro lado, o grupo de profissionais céticos da ciência que contesta esta investigação argumenta que não há provas suficientes para justificar todo o empenho, fornecimento e dispêndio de energia e tempo dos cientistas, bem como de recursos financeiros. Por fim, a Astrobiologia é uma ciência que beneficia a sociedade ao fornecer subsídios de conhecimento com potencial significativo para exploração na farmacologia, na indústria alimentícia e agrícola e no tratamento de biorremediação de ambientes contaminados por petróleo.
Palavras-chave: Filosofia da Ciência; Astrobiologia; Extremófilo; Recursos financeiros

Introduction

Astrobiology, according to the American microbiologist and winner of the Nobel Prize in Medicine, Baruch S. Blumberg, is an area concerned with the issues related to the origin, evolution and distribution of life in the Universe (Blumberg, 2003). However, the possibility of extraterrestrial life remains a major objection to skeptics in this modern scientific field. After all, would it be possible to do science from a subject in which there is no evidence of its existence? Is it justifiable to expend financial resources on the search for life on Mars, Europa or any exoplanet?

The motivation for the development of this scientific work is to present the field of Astrobiology as a valid field of science that enjoys full autonomy. Furthermore, it is worth noting the current researches for extraterrestrial life are already capable of presenting valid results from the point of view of good science.

Thus, the objective here is to present the main aspects that provide science with the support to receive financial resources to develop its research. Although, according to Noack *et al.* (2015), there is no longer any questioning about the social legitimacy of Astrobiology as a scientific field, despite the fact there are still many skeptics who remain objecting to the spending of financial resources on the search for extraterrestrial life.

Moreover, this work of a scientific nature was built from exploratory research, in which, through arguments, it was sought to substantiate and bring light to the questions about whether the research carried out by Astrobiology using financial resources is justifiable. The sections were divided into aspects of spending

economic resources on science, with the aim of relating how part of social progress is linked to the progress of the scientific field itself. Subsequently, a section is presented that discusses the source of credibility and social legitimacy related to the theme of the search for extraterrestrial life for non-practitioners of science. In addition, the factors that consolidate the field of Astrobiology to have credibility and social legitimacy, differentiating it from pseudosciences, are addressed. Finally, views unfavorable to the development of this activity and arguments in favor of research in the field of Astrobiology are presented.

Economic resources spent to science

Modern science, in general, is no longer an enterprise that requires only energy and time among those involved in research, but also needs money so that research programs can be developed. Without money, nowadays, it is practically - if not completely - impossible to carry out modern scientific practice, at least at the highest level. The cost of chemical reagents for scientific experiments, construction of lenses for telescopes that observe the sky, in addition to all conservation and maintenance of scientific instruments, all these factors mentioned have very high values that a practitioner of modern science is unable to subsidize alone - without resources from the State or from private sources (companies or industries). In other words, modern science has become an extremely financially burdensome social activity. From this perspective, then, what makes science credible to receive such an investment of financial resources? What regulates the actions that develop in the scientific field? And in the case of Astrobiology, how are these actions regulated and given social credibility?

As for the first question, Thomas Kuhn (1970) would argue saying that normal science has an indisputable efficiency in producing information and transforming it into knowledge. Conversely, but not opposite, Tymothi Lenoir would argue by saying that: "*instrumentation, experiment and practical interpretive work are shown as simultaneously participating in an economy of social, political and cultural interests.* (Lenoir, 1998., pg. 21)." Lenoir also warns that, "*...in certain critical situations, the commitment of scientific investigation*

with practical objectives has been essential to the growth of knowledge" (Lenoir, 1998, p. 226).

Well, science, then, both helps in the construction of social facts that generate the development of social life, as it is also socially constructed by society's interests regarding its needs. This social dynamism, according to Pierre Bourdieu (1984, p.82), is part of the social constituent through the relationship between the specific interests of the field and the habitus. In short, modern science is shaped by the internal relationships between its agents and institutions in its social microcosm.

With regard to the regulation of actions from the scientific field, the French social psychologist and philosopher David Émile Durkheim (1858-1917), the Polish anthropologist Bronisław Malinowski (1884-1942) and the American sociologist of science Robert Merton (1910-2003), would answer that these procedures are related to the process of institutionalization of science. In general, for them, scientific institutions play a fundamental role in building authority, credibility and legitimacy of the scientific field before society. Institutions are responsible for organizing, structuring, establishing goals and objectives, creating criteria for validating and certifying information, publishing or rejecting content for their community and establishing the development of hierarchies within their scientific community - government agencies, societies and academies of sciences, institutes and research centers. In the words of Merton (1942): "*while stabilizing and regulating the system, they ensure its autonomy in relation to the social microcosm, seeking to homogenize the scientific field in the face of the actions and activities carried out by its practitioners*". This, then, would differentiate the scientific field from other social fields, this movement being called *differentialism*.

However, the French sociologist Bruno Latour contests this perspective, which is based on a dichotomous principle between science and society. Scientific sociability, according to Latour (1996), also generates credibility from other factors, such as accredited undergraduate programs, especially doctorates in the area and textbooks. In addition, scientific meetings and events (seminars, symposiums and congresses), memos, media reports, email messages, telephone conversations, every formal and informal conversation, every element of public and not-so-public dialogue about science contributes to the construction of its legitimacy, and all these configurations and factors "act" within a context that Bruno Latour (1996) would

call actor-network. In this way, science and scientific institutions not only forge the structures of society, but due to their dependence on economic capital, they also begin to be shaped by socio-political scenarios.

In general, it is common to think that scientific development can be harmed when aligned with political interests. There is the puritanism conception, in which the ethos of science can suffer external influences, harming the progress of scientific research to the detriment of the interests of the State. Lenoir even asks, reflecting: "*is the development of science, in fact, so immune to external pressures? Can't good science be part of a seamless network of political and economic institutions, supported by sets of value orientations and ideologies?"* (Lenoir, 1998., p. 99). This structure consolidates a network of actors-actions-situations-world. In short, science is a social construct!

Well, but how does this network of different aspects manage to establish a source that justifies the development of a scientific activity to the public that does not practice science? How does this public come to believe and where does this "willingness to believe" in the possibility of extraterrestrial life existing on other worlds come from?

Source of credibility for non-practitioners of science and their willingness to believe

Generally, thoughts around the possibility of the existence or not of extraterrestrial life (ETs) - whether intelligent or not - are socially characterized as prominent fictional[3] elements in modern Western culture. These aspects are even quite represented and symbolically constructed through mass media such as; cinema, television and more currently social networks. These public representations of science are a subject worthy of study because of the authoritative position, belief formation and sometimes even generating credibility of these subjects in society. The public representation of science, according to Zehr (2000), is *"part of scientific*

[3] It is a term from the Latin fingere that is related to anything that does not fit the facts. However, in philosophy it is a construction elaborated by the imagination thanks to which an individual believes he can solve a real problem (metaphysical, logical, moral or psychological).

work, conducted by professional scientists and other spokespersons who are actors[4] *in the worlds or social networks of science*".

In fact, over the decades countless works have been dedicated to this subject - books, movies and TV series. Among the works, the best known and perhaps the most influential is War of the Worlds (1897) by H. G. Wells and more contemporarily Cosmos by Carl Sagan with a book version and a TV series - recently reissued by Neil DeGrasse Tyson. The proliferation of films with this theme and the dissemination of the subject globally can be considered the main factor in associating both the advent of modern science fiction and the beginning of our cultural fascination with the possibility that ETs exist.

It is important to emphasize that the perspectives and opinions on the scientific controversies of the time developed by these different media represent an important element - often - absent or invisible in the amid of the academic and even cultural relationships that we inherited and that we continue to tell about this scientific field, which emerged and nowadays called Astrobiology. Even if it is considered that science is a system of inherited conceptions expressed in symbolic forms, through communication, perpetuation and development of knowledge and attitudes, according to cultural anthropologist Clifford Geertz (1973), it could be considered a cultural expression of society. Science would be culture.

To some extent, science expresses sociocultural aspects, as scientists claim to act as arbiters of reality and non-scientists grant them this authority. The imposition of science practitioners plays this role of social prominence (power and authority), according to the philosopher Michel Foucault (2019), from the everyday scientific discourse (communication, rhetoric) that works as a means of creation and operation in that reality. This modus operandi of science, it seems, makes its actions justifiable, such as the economic resources made available and used in favor of activities in the scientific field for its progress and social development.

However, how are these actions regulated and given social credibility, in the case of Astrobiology? Mainly, how does the research tradition of searching for extraterrestrial life through Astrobiology differ from other areas in order to have authority, credibility and social legitimacy?

[4] Actors are events or entities, but not "substances". In other words, it is not something that pre-exists, it is finished and endures, and cannot be differentiated from its manifestations and relationships (Latour, 1996).

Factors that provide credibility and social legitimacy to Astrobiology

According to Dick (1998), the research tradition of searching for extraterrestrial life is even older than the Space Age. However, although all this curiosity, according to Lucas John Mix (2018), has historical motivations still coming from the civilization of ancient Greece - from the clash of ideas between singularists and pluralists. The scientific search for extraterrestrial life became officially established in the science lexicon only when NASA established its Astrobiology Program in 1998 with the creation of the NASA Astrobiology Institute (NAI).

Since then, the regulation of activities developed in the tradition of research in the search for extraterrestrial life through Astrobiology, has been done by international institutions such as the International Space Research Committee (COSPAR) and the International Astronomical Union (IAU), in Brazil it is done through its Brazilian Society of Astrobiology (SBA) and Brazilian Academy of Sciences (ABC), in the USA through the US National Academy of Sciences (NAS), in Europe through the European Institute of Astrobiology (EAI), among many others that exist globally - all representations of scientific authority formed by their scientific communities - contributing to the regulation and construction of legitimacy in the field of Astrobiology and the search for extraterrestrial life. In general, these entities are widely accepted as judges that regulate scientific activities within a field, so that statements and rhetorical communications through their pronouncements generate credibility and legitimacy that become widely accepted as shared values among members of the scientific community. - this symbolic value is consequently socially validated.

However, as exposed by Latour, credibility goes beyond intra-institutional relations, which, from the differentialist perspective, separates science and society. The legitimization of the field also passes through other actors and the scientific sociability of Astrobiology, has a great influence coming from a series of reports developed in the middle of the 20th century, over decades, by the Space Studies Board (SBB), in which the scientific priorities that should be developed by the agents involved in this field. This type of procedure, as already mentioned, is

intended to help establish and maintain the field as a legitimate science, effectively enforcing its boundaries.

A fact that stands out in these SBB reports is that scientific priorities are expressed together with philosophical bases that can serve as arguments that justify the development of space research programs. The Academy's Space Science Board, in one of its reports, as John M. Logsdon of the National Air and Space Museum (2001, p. 142) expounds that: "*a very exciting philosophical basis for a space science program would be to learn as much as possible about the behavior of terrestrial life forms in space and under the conditions of spaceflight, and searching for extraterrestrial life.*"

According to Billings (2012), this occurred on October 20, 1959, after NASA contacted SBB. Logsdon also mentions that the SBB credible, justifies and legitimizes actions related to the research traditions of the search for extraterrestrial life through another excerpt of the same report, in which SBB expresses itself saying that: "*the philosophical implications of a discovery that the life actually exists elsewhere than on Earth are tremendous and certainly of interest to the entire world as well as to the scientist*." Now, here is the SSB's role in helping to form, guide and legitimize the tradition of searching for extraterrestrial life as NASA's research program has officially begun.

During the last decades, the search for extraterrestrial life has been highlighted in the scientific field. However, it's important to say, the research tradition of searching for extraterrestrial life is a field in its teens, and still struggles sometimes to be taken seriously in the world of mature sciences. Nowadays, according to Noack (2015), there is no longer any questioning about its social legitimacy, in which this is mainly due to the institutionalization of this research tradition, such as the creation of a research program, adequacy of its normative standards and adoption by the scientific community of the term "Astrobiology" to globally designate this scientific field.

Faced with the numerous criticisms that have always existed in the research tradition of searching for extraterrestrial life, for being considered a frontier, dark and speculative. There are still great advocates, which are spending their time and resources because they want to be capable of finding extraterrestrial life. Nowadays, the institutional declaration validating the search for extraterrestrial life has meant

that, at the beginning of this century, Astrobiology is configured as one of the scientific branches that receive the most financial investment and human resources (Castillo-Rogez et al., 2021). The Committee on the Planetary Science Decadal Survey has been conducting surveys for decades. Steve Squyres, advised in one of these documents that the scientific community declares: "*Astrobiology as an important cross-cutting theme of NASA's planetary science activities and part of the core scientific scope of research*." However, there will always be questions - mainly by skeptics of the field - about whether the expenditures from public financial resources for the development of this research program are justifiable?

Are the financial resources used in modern Astrobiology justifiable?

Evolutionary biologist Ernest Mayr would respond that "*this type of research program is "hopeless", "waste of time", and would even say that "we have to deal with realities - not wild dreams*" (Garber, 1999). Mayr argues that since the beginning of life on Earth, approximately 50 billion species have evolved, but only one has developed technology. In his Darwinian terms, "*If intelligence has such high survival value, why don't we see more species develop it*"?

Critics of the idea of the search for extraterrestrial life, Theodosius Dobzhansky, George Gaylor Simpson, Frank Tipler, supported the idea that Earth was probably the only one to harbor intelligent indigenous people with the capacity to develop technology, at least among the planets in our galaxy. Mathematical physicist Frank J. Tipler defended his objection to the search for extraterrestrial life, saying that we should "*concentrate our efforts on solving problems on Earth before we concern ourselves with the question of life on other worlds.*" Tipler's argument (1981) was based on the probability that the success of this type of research would be very small and Mayr endorsed this perspective saying that "*for practical purposes, the possibility of finding life beyond Earth, was so unlikely that it could be considered zero*". It is also worth remembering here Simpson's criticism (1964, p.769), which refers to this type of research as "*a 'science' that had not yet demonstrated whether its object of study existed!*"

However, the astrophysicist William Heffeman (1981, p.530) in his words would argue that:

> "In the absence of unambiguous evidence for or against extraterrestrial life, the discussion depended, and still depends, on analogies between conditions prevailing on Earth and on other planets. However, speculations are not to be discounted, for reflection on plurality would not have advanced if scientists had insisted on the kind of tangible evidence that professional scientists at Hetherington demanded."

Obviously, the acceptance by the scientific community of researching an object based on speculation and a few indications, without evidence of its existence, generates great opposing exaltations. However, American astrobiologists Christopher F. Chyba and Kevin Hand (2005) argue: "*If exobiology (or astrobiology) were understood only as the study of extraterrestrial life – which it is not – Simpson's criticism would remain strictly true, but it wouldn't invalidate the research and that might seem bizarre to many astronomers or physicists. However, astrophysicists spent decades studying and searching for black holes before amassing the current evidence that they exist...*"

So, talking about the viability of the existence of theoretical black holes or the existence of extraterrestrial life (whether intelligent or not), is perhaps not so inappropriate if accredited part of this "faith" in metaphysical assumptions. Also, it turns out, microbial life doesn't seem so impractical to exist on other worlds.

The search for extraterrestrial life, currently, by science practitioners, could be compared to the "faith" of pioneers such as Pedro Álvares Cabral, Christopher Columbus and many others, left their hometown, and after a certain time contemplated in across the sea, far away, another world, a world still unknown until then. At great distances it was possible to see a lot of green from the countless trees that were there, as many trees or even more than there were in his hometown. They could ask themselves: "Is this a world similar to ours, that is, is it habitable?"

Skeptics and pessimistic science practitioners, such as Theodosius Dobzhansky, George Gaylord Simpson, and Frank Tipler, would probably say that this terrain appears to have some configurations suitable for life to exist, and some people might attribute it to be a world like ours, but not see beings. alive would be proof that it would be an "inhabited" environment. However, this sentence is not coherent. Thinking about it, we cannot say: "inhabited", just because no one is seen on this land – after all, absence of evidence is not evidence of absence (Sagan and Druyan, 1997, p. 213). Taking this path is a mistake. To think that they are not there simply because we do not see them, would be to jump to hasty conclusions and easily

fall into the same mistake made by people regarding microscopic life... The world was full of microscopic animals, but as no one saw them, they didn't exist.

On the other hand, optimistic inductivists such as Carl Sagan, Frank Drake and Jill Tarter would respond that, such as it is not possible to see the inhabitants of other worlds given the distances and deficiencies of our instruments, making it impossible to observe, verify and deny that these other worlds do not are habited. Thus, nothing can be said other than that it is necessary to continue investigating, as there is the possibility of it being in addition to being habitable, the possibility of also being habited or not.

Carl Sagan warns and points out that discussing the relative probability of receiving an ETI signal is fallacious (Garber, 1999) - In his words: "*we will not know if there are signals until we look for them seriously*". Another point that follows, posed by the Swedish philosopher Erik Persson (2013) is: "*Exist any guarantee that would resources saved by abstaining from astrobiological research motivated by pure curiosity be enough to play an important role in the treatment of environmental problems here on Earth or would they be reallocated to military purposes?*"

It should also be said that pure "disinterested" research motivated by curiosity led us, for example, to the discovery of the greenhouse effect process from the study of the atmosphere of Venus and the development of the internet, among many others. So, this explains the interest, curiosity and mobilization among science practitioners, in addition to the use of a good part of the economic resources made available for the development of research in this field of search for extraterrestrial life on icy moons of Europa and Enceladus, Mars or even even on exoplanets.

Conclusion

Although it is indisputable that there are numerous important problems that urgently need solutions here on our own planet. If not provided financial resources for the field of Astrobiology to carry out its research, would this solve part of these problems? Obviously, the distribution of economic resources needs, in addition to scientific foundations, ethical and moral foundations. There are ethical issues such

as whether the effort put into research driven by "curiosity" is worthy of both time and financial expense. Here were presented some arguments, which respond to this contestation. There is some research in other fields of science that develop this kind of activity (e.g. dark energy research). On morality questions arise such as: What is a fair distribution of costs and who should pay for this type of research?

Astrobiology, like any other scientific field, must as a full and autonomous science have its share of receiving resources not only from private entities, but the State must ensure part of this support for these researches. Despite this, the field of modern science fundamentally seeks answers about the origin, evolution and the possibility of life existing outside the Earth. Studies with extremophiles provide us with knowledge subsidies that have great potential to be explored by pharmacology, the food and agricultural industry, bioremediation treatment of environments contaminated by oil, among several other applications, with microbiology being just one of the sub-fields present in Astrobiology.

In the end, Astrobiology will not be able to escape the same questions that all other scientific fields also go through regarding its application and social return. However, science has great social support not only for being able to solve puzzles, but also for contributing to social progress in finding cures for diseases through the creation of vaccines and medicines, generation of technologies and gadgets that are increasingly advanced. Astrobiology is part of that. After all, Astrobiology is science! Thus, financial resources spent in research on the field of Astrobiology are justifiable.

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