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The synthetic thesis of truth helps mitigate the "reproducibility crisis" and is an inspiration for predictive ecology

La tesis sintética de la verdad ayuda a mitigar la "crisis de reproducibilidad" e inspira a la ecología predictiva

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Abstract

There are currently serious concerns that published scientific findings -including biological results- often fail to be reproducible, and that some solutions may be gleaned by attending the several methodological and sociological recommendations that could be found in the literature. However, researchers would also arrive at some answers by considering the advice of the philosophy of science, particularly semantics, about theses on truth related to scientific realism. Sometimes scientists understand the correspondence thesis of truth (CTT) as asserting that the *next* unique empirical confirmation of a hypothesis suffices to attribute truth to it provisionally. Such empiricist bias is not necessarily at the core of CTT, but Mario Bunge proposed the synthetic thesis of truth (STT), based on CTT, to explicitly avoid the bias. STT requires considering a hypothesis corroborated both by purely empirical confirmation and external consistency or compatibility with the bulk of existing background knowledge (systemicity). While a capricious understanding of CTT could be rigged to recommend the "one shot game" in hypothesis testing, STT clearly demands the

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use of multiple approaches, empirical as well as theoretical, and it asserts that a scientific test is effective to the extent to which it is neither purely empirical, nor viewed in isolation. Pattern consistency (empirical control) together with an understanding of causal relations (rational together with empirical control) make confirmed hypotheses robust and more reliable. The militancy of the double mechanism of hypothesis control can help mitigate the reproducibility crisis in biological research. Earl Werner's research program in community ecology is an example of the (implicit) use of STT criteria, which leads to the development of reliable, cross-checked, ecological results, with high predictive capacity.

Keywords: philosophy and methodology of science, scientific realism, truth criteria, empirical and rational support, causal mechanisms, ecology.

Resumen

Parte de los resultados de investigación publicados -incluyendo numerosos hallazgos en biología- no se han podido replicar en estudios posteriores, lo que preocupa a científicos y editores, quienes han recomendado valiosas sugerencias metodológicas y sociológicas para mitigar el problema. En mucha menor medida, los investigadores han evaluado sugerencias de la filosofía de la ciencia. En particular, qué enfoques semánticos sobre las tesis de la verdad en ciencia y tecnología resuelven mejor la "crisis de reproducibilidad". Numerosos científicos interpretan que la clásica tesis de la verdad por correspondencia (CTT) implica que la próxima corroboración empírica de una hipótesis a través de un único experimento es suficiente para confirmarla provisionalmente. Aunque ese sesgo empirista y simplista no surge necesariamente de la CTT, el empleo de dos criterios de verdad en forma explícita está dirigido a corregirlo: la tesis sintética de la verdad de Mario Bunge (STT) requiere, para considerar una hipótesis confirmada, que tanto la mayoría de la evidencia empírica disponible (consistencia interna) como del resto del conocimiento confiable actualizado (consistencia externa) corroboren la hipótesis en cuestión. Mientras que una lectura caprichosa de la CTT puede emplearse para manipularla y dar fundamento a competencias "de un solo tiro" en la investigación, la STT requiere el empleo de múltiples aproximaciones, tanto empíricas como teóricas, y afirma que la prueba científica será efectiva en la medida en que no sea puramente empírica ni única. La consistencia de patrones (control empírico) junto con la comprensión de las relaciones causales que los generan (control racional y empírico) hacen más robustas y confiables a las hipótesis confirmadas, mitigando la crisis de reproducibilidad en la investigación biológica. El programa de investigación en ecología de Earl Werner es un ejemplo de uso (implícito) de los criterios de STT para aumentar la capacidad predictiva de la ecología.

Palabras clave: filosofía y metodología de la ciencia, realismo científico, criterios de verdad, apoyo empírico y teórico, mecanismos causales, ecología.

1. Introduction

There are currently serious concerns that published research findings in several scientific disciplines -including biology- often fail to be reproducible, which has given rise to the so called "reproducibility crisis" (Ioannidis 2005a; Lehrer 2010; Editors 2016). The lack of reproducibility means that different results, or even opposite results, are often obtained during the test of the same scientific hypothesis with the same type of experiment (or a different, although equally pertinent, one). The ability to reproduce observations or experiments is integral to science, however failure to do so also appears to be a routine part of research (Editors 2016). Some amount of irreproducibility is inevitable, since sources of variability in nature and society are infinite (Ives 2018), and are thus rather difficult to anticipate. Yet, according to a survey carried out by Baker (2016), there is a "bigger issue" that needs to be fixed. One-third of the survey respondents expressed that they think about the reproducibility of their own research daily, and more than two-thirds discuss it with colleagues at least monthly. The bigger issue arises because some researchers think that the test of a hypothesis is a "one shot game" (i.e. a matter of a single, purely empirical test), especially if the test corroborates a novel and charismatic hypothesis and, therefore, facilitates rapid publication (Cohen 2017).

From a philosophical point of view, the reproducibility crisis is associated to the criteria of truth and the ways truth can be established in science provisionally. Several philosophers are skeptical about scientific realism, the doctrine that suggests that the goal of science is to give an account of reality (Lombardi 2018; Mahner 2001), but practicing scientists are used to the idea that their main goal is to search for truth, and that truth is correspondence between an assertion about nature or society and the way nature or society is or works. That is the correspondence thesis of truth (CTT), an idea that may be traced back to Aristotle, Plato, and Aquinas, and that was carefully elaborated in the last century by philosophers and logicians (e.g. Russell 1918; Tarski 1983; Bunge 2012). In a simple way, it asserts that truth corresponds to, or with, a fact: "a proposition (e.g. a prediction) asserting that fact *f* is the case is true if, and only if, *f* is actually the case" (Bunge 1999; 2012).

From a methodological perspective, which is more familiar to researchers, the reproducibility crisis is linked to the dilemmas related to scientific hypothesis testing. In factual science and technology, where the adoption of CTT has been of great use, hypothesis testing requires controlled observations or experiments. Although some practicing scientists may act automatically during such tests, most of them are often willing to follow some methodological advice. For example, they consider that hypotheses and theories are not confronted directly with facts (which are sometimes unobservable) but with data or empirical indicators that describe those facts indirectly (Marone and Galetto 2011). Scientists are also willing to admit that the establishment of the truth value of hypotheses and theories via the establishment of the truth value of some of their genuine predictions is a nonlogical but *seductive* (Bunge 1999) inference that only suggests the truth of those hypotheses and theories. Furthermore, and regarding the lack of reproducibility of results, several methodological and practical actions, such as refining the experimental design, increasing sample size, improving data collection and statistical inference, are advised and followed by scientists.

However, researchers are less inclined to follow philosophical advice despite the implications it may have on science practice. This is unfortunate because some truth criteria may contribute a better foundation than other criteria to research programs that look for robust, replicable results. The CTT does not necessarily invite the testing of a hypothesis using a single, purely empirical approach (e.g. one correlation with a high number of points, or a single statistical test with a very small *p*-value), but researchers that practice the "one shot game" may be promoting the most empiricist heart of the CTT: the idea that a hypothesis can be proven provisionally to be true merely if the *next* (single, restricted) data set confirms one prediction genuinely deduced from it. This is a weak interpretation of CTT that, unfortunately, is often practiced and could be encouraging the report of contingent, unreproducible results.

The philosopher of science Mario Bunge has proposed a subtle (although powerful) modification of CTT that may help circumvent its purely empirical, weak interpretation. Bunge explicitly divided the correspondence criterion of truth into two complementary criteria. The synthetic thesis of truth (STT, Bunge 2006, 261) asserts that empirical confirmation (i.e. the one provided by the *next* controlled observation or experiment) is necessary, but not sufficient, to assign a truth value to a hypothesis, since external consistency, or compatibility with the bulk of the background knowledge, is needed as well (Bunge 2006; 2017). The explicit advice of simultaneous empirical and rational controls of scientific hypotheses may help prevent the "slipperiness of empiricism" (Lehrer 2010; Bunge 2017) that lies behind the reproducibility crisis. Our hypothesis is that if both kinds of control were carefully used before spreading the results in specialized journals, at least some nonreplicable findings would not reach the literature, avoiding subsequent confusion. But, let's begin by assessing the theses of truth in some detail.

2. The correspondence and synthetic theses of truth: an in-depth assessment

CTT and STT refer to factual statements and they capture the intuition that factual truth consists in adequacy to reality, unlike their formal (e.g. mathematical) counterpart. But the CTT is sometimes used to assess adequacy in a way that leaves out systemicity or external consistency (Bunge 1999). However, this problem is corrected by the STT approach (Bunge 2006), an embryonic theory compressed into a definition and two criteria. The definition is the same as CTT (i.e. a proposition *p* asserting that fact *f* is the case is true if, and only if, *f* is actually the case). Yet, as it was advanced, the two criteria of synthetic truth are (a) that *p* is compatible with (and exceptionally equivalent to) the relevant empirical evidence (internal consistency), and (b) that *p* is consistent with the bulk of the pertinent background knowledge (external consistency: a more rational, not purely empirical, criterion) (Bunge 2006; 2017).

Some examples on how people establish the truth in ordinary life and profession may highlight the everyday use of the STT criteria. When some parents decide to send their young daughter to learn to swim in a gymnasium, they will usually consider that there were no antecedents of serious accidents in the gymnasium as evidence in favor of their decision (a purely empirical support), as well as the results of a detailed inspection of its facilities showing that all necessary security measures that could eliminate the main causes of accidents (i.e. unfit mechanisms of several types) had been taken. When a physician prescribes a certain medicine to a given patient, the patient could take it simply because he trusts the physician. However, a curious and skeptical patient would only be willing to consider that the therapy is reliable after an in-depth inquiry. For example, after knowing that 100,000 patients had previously taken the drug and the drug was 99.9% effective (a purely empirical support), and that researchers could correctly describe the action mechanism of the medicine, discarding, above reasonable doubt, side effects through several possible metabolic pathways (a more rational as well as empirical support).

Bunge (1998) showed that external consistency is a key requisite for assessing the degree of truth (or untruth), for example, of pseudoscientific assertions. Pseudoscience can eventually predict facts correctly by chance, but its assertions suffer from lack of compatibility with the bulk of the up to date background knowledge, especially well-established causal mechanisms that explain the occurrence of such facts. Further, when a researcher attempts to solve some unsolved scientific question, external consistency invites a careful assessment of the background knowledge before producing a *plausible* hypothesis (i.e. a hypothesis that has not yet been empirically tested, but is deemed verisimilar and deserving of empirical testing in the light of some well-established body of knowledge; Bunge 1999). In fact, plausibility checks are an essential component of Bunge's scientific methodology because they allow the assessment of alternative hypotheses *a priori* in an objective manner to decide which of them is a better candidate for investing our resources in their empirical testing, discarding wild or insufficiently grounded conjectures. Thus, the external consistency criterion allows the researcher to allocate finite resources in a more efficient fashion.

But what background knowledge is relevant for such a plausibility assessment? According to Bunge (1999), a hypothesis may be said to be empirically plausible with respect to a set of relevant data, if the overwhelming majority of such data confirms it, and a hypothesis may be said to be theoretically or rationally plausible if it is consistent with the bulk of the background knowledge relevant to it. Thus, the plausibility of a new hypothesis is sustained on both empirical and theoretical backgrounds, which coincide with the two criteria of synthetic truth for hypotheses in general. In sum, the weighting of the degree of truth of a hypothesis has two empirical instances (one previous and one during the test), and two theoretical instances (one previous and one after the test). But what characterizes the theoretical support of a new hypothesis? Bunge proposes all possible serious candidates ("the bulk of background knowledge") but, based on his ontology and epistemology (Bunge 1997; Marone and Bunge 1998), the knowledge of causal mechanisms is a key candidate:

> [while assessing a hypothesis] We have got used to the idea of multiple controls, both empirical and theoretical ... In short, theorification and independent cross-checking make up for the weakness of every single empirical test, which by itself is or can be made circular. An empirical test is effective to the extent to which it is neither single nor purely empirical. (Bunge 1998)

In sum, in Bunge's philosophy of science, theoretical as well as empirical support is needed for assessing new hypotheses and provisionally establishing their truth. The CTT may be rigged as demanding only empirical support, but the STT explicitly requires both empirical and theoretical support. So, what consequences would adherence to, and the epistemic militancy of, STT have for the reproducibility crisis in science, and what kind of research program is developed under the inspiration of STT?

3. The synthetic thesis of truth and the reproducibility crisis

Ioannidis et al. (2001) evaluated 370 studies by meta-analysis addressing 36 genetic associations for various outcomes of disease. They showed that lack of reproduction is frequent in genetic epidemiology: the results of the first study, which often suggested a stronger genetic effect, correlated only modestly with subsequent research on the same association. A few years later, Ioannidis (2005b) examined all the original clinical research studies published in major general clinical journals in 1990-2003 which had received at least 1000 citations in the literature. These results were compared with subsequent studies on the same topic of similar or larger sample size and similar or better controlled designs. Contradiction (19% of the 36 studies were challenged by subsequent ones) and initially stronger effects (another 19%) were found in the survey. The high public impact of these meta-analyses on clinical research attracted the interest of other scientists and editors on the topic, increasing the number of articles and editorials on a subject that, notwithstanding, had woken interest long ago (e.g., Smith 1920; Hairston 1989; Polis et al. 1998; Werner 1998).

Both bias and genuine natural variability might explain why early studies tend to produce more false positives than subsequent ones. Several articles have revised the main [non-fraudulent] causes of the reproducibility crisis. Ioannidis (2005a) blamed studies of small sample and effect size, and flexible designs (technical causes), together with the attraction that hotter or fashionable ideas have in several scientific fields (mostly sociological causes). More recently, Ioannidis (2014) summarized the research practices that may help increase the proportion of true research findings: the adoption of reproducibility practices, standardization of definitions and analyses, better statistical methods, more appropriate statistical thresholds, improvement in study design standards (technical practices), together with the recording and sharing of results, large-scale collaborative research, and improvement of peer reviews (mostly mixed, sociological and technical practices). Moreover, Young et al. (2008) called attention to the responsibility of journals since the small proportion of results chosen for publication may be clearly unrepresentative of the real world because the process of selectivity is based on a weak assumption, that selectivity is equivalent to quality. Higginson and Munafó (2016) reinforced the idea indicating that researchers acting to maximize their publication rate should spend more of their effort seeking novel results and conducting small studies that have only 10%-40% statistical power. They suggested that if such figures were true, half of the published studies would report erroneous conclusions. Not surprisingly then, editors of Science (McNutt 2014) and Nature (Editors 2014) have declared that the journals want to do their part in raising publication standards for the benefit of scientists and of society, avoiding publication of unreproducible results. Most of editors' initiatives coincide with the recommendations cited above and are directed to increase transparency by improving design and statistics (e.g. the articles should describe criteria for defining sampling size, the exclusion of outliers, randomization), and strengthening sociological practices, such as all data and materials necessary for understanding, assessing, and extending conclusions of a manuscript must be available to any reader, as well as the possibility that research groups not involved with the original study replicate selected findings (Berg 2018).

Important and valuable as the proposed corrective initiatives may be (Editors 2014; Ioannidis 2014; McNutt 2014; Berg 2018; Ives 2018), they could be insufficient to tackle the reproducibility crisis because they only focus on the most empirical aspects of hypothesis testing, on the improvement of the *next* test (e.g. refining the experimental design, increasing sample size, improving data collection, randomization, and statistical inference). This is despite Ioannidis (2005a) had offered a comprehensive criticism and accurate diagnosis of the main causes of the reproducibility crisis early on when he stated that "it is a consequence of the convenient, yet ill-founded strategy, of claiming conclusive research findings solely based on a single study assessed by formal statistical significance, typically for a *p*-value less than 0.05". Ioannidis (2005a) was blaming the "one shot game", and the empiricist heart of CTT. Despite this early warning, the assessment of the mechanisms causing real patterns, as a rational control of the reproducibility of those patterns, is often missing in the specialized literature. Ironically, the use of putative mechanisms as a means of controlling the degree of truth of disparate phenomenological results is absent from the search of the mechanisms causing the reproducibility crisis.

Systemicity may also help, since an unwise bias towards novelty may be another factor that is increasing the reports of false positive results (Higginson and Munafó 2016; Cohen 2017). External coherence is indispensable for discarding wild conjectures whose main –and perhaps sole– virtue is novelty, while being at odds with the bulk of updated background knowledge. External coherence, however, does not hinder innovative science, since it only demands consistence with *most* –not all– scientific knowledge (Bunge 1998). Further, it promotes innovation through the search of the usually unknown mechanisms that underpin clear natural or sociological patterns. "We can have greater confidence in our findings if they are consistent with mechanisms that are both reasonable and supported by other kind of evidence" (Johnson 2002). In his idea of a research program in wildlife science, Johnson (2002) emphasized the STT, without using the concept: we have greater confidence in our ideas if they are consistent with the output of our most recent observations or experiments, as well as correspond with plausible mechanisms whose existence was established by using independent, usually experimental, evidence (Bunge 1997; 2017; Werner 1998; Marone et al. 2000).

Certainly, a great number of researchers employ –although sometimes in a tacit way– both criteria of STT. For example, Munafó and Smith (2018), in trying to fix the reproducibility crisis, recently proposed that sheer repetition of the same experiment is not enough. They recalled an extant tradition in the philosophy of science (e.g. Bunge 1998; Stegenga 2009) that can be traced to William Whewell and that is also present in practicing science (Smith 1920; Marone et al. 2000; Johnson 2002). The core of such tradition is what Munafó and Smith (2018) called "triangulation", perhaps more widely known as "consilience" or "robustness". It consists in the strategic use of multiple approaches to address the same question. Each approach has its own assumptions and, thus, the results that agree from different approaches (and assumptions) are less likely to be artifacts. Munafó and Smith (2018) also emphasized the always important sociological aspects of scientific enterprise when they assert that, although triangulation is supposedly how science is meant to operate, in today hyper-competitive environment scientists often lose sight of the need to pursue distinct strands of evidence. Triangulation is a particular kind of redundancy and cross-check of hypotheses embedded in the STT tradition: by changing the kind of experiment (and its contingent assumptions), robustness is not merely inductive consistence between repetitions but redundancy under different assumptions. The robust result is sustained by inductive, as well as deductive, foundations (several predictions, founded on different assumptions, hold). It is a modest way of using background knowledge (assumptions in this case) to give multiple support to the working hypothesis, but it is an important way.

To conclude we will review examples of the practical application of STT to research questions in ecology and environmental sciences. In doing so, we will put the research program on community ecology, proposed and carried out by Earl Werner (1998) and colleagues, under the spotlight.

4. The synthetic thesis of truth and the research program in community ecology

The idea of employing multiple controls, empirical and theoretical, to reliably predict and explain natural phenomena is implicit in the way several natural scientists conduct research. One outstanding example is Earl Werner's research program in community ecology because of its balanced epistemological, methodological, and scientific components. In Werner's (1998) words: "The research program that I discuss here emphasizes the importance of integrating descriptive/comparative, experimental, and theoretical work to approach ecological questions. It is the iteration among theory, experiments, and a specific field pattern that is so valuable". According to Werner (1998), reliable knowledge requires descriptive, experimental, and theoretical evidence simultaneously. Such a research program accomplishes the three main goals of science (i.e. the description, explanation, and prediction of phenomena; see Bunge 1998). But a key component to make the program function is the integration of evidence, and Werner (1998) remarks that a clear view of how to integrate the different aspects of the scientific process into a successful research program is what is lacking in most discussions.

Particularly interested in prediction, Werner (1998) found that experiments that make no contact with a given research program may fall far short of providing a predictive basis because of the lack of integration with a strong theoretical foundation, even more if the experiments are not directed at uncovering mechanisms. The theoretical component would be the glue that holds these studies together at various levels. But more than this, to prevent a program from being deflected into unrealistic avenues, such a program must be related to the context provided by a field pattern, and the self-correcting steps that pattern avails. The attempt to take predictions from highly controlled studies back to more natural conditions is a critical step in a predictive research program: "Specifically, studies must be integrated in such a way that the artifacts introduced by experimental control are eventually cancelled out by the guiding hand of reality, and the intractableness of reality must be whittled away by the surgical knife of control" (Werner 1998). The incorporation of theoretical components based on mechanisms at the individual level, sometimes called "natural history" although they are often measured experimentally (e.g. morphological, physiological, behavioral mechanisms), allows the establishment from individual ecology of quantitative predictions at the community level. Such predictions are especially valuable because they are constructed independently of the community-level phenomena or pattern. By means of integrating theoretical, experimental and descriptive elements in a research program, hypothesis testing is an exercise embedded into Bunge's STT: the researcher aspires to build a functional whole (predictive and explanatory theory), based on the assumptions and hypotheses sustained on natural history, especially about causal mechanisms identified by experimentation, all of them controlled by a realistic pattern in the field (descriptions or comparative studies). The hypotheses in the program are supported not only by the data at hand (internal consistency) but also by theoretical expectations and data coming from alternative disciplines (external consistency). It clearly sounds much more complex and labor intensive than the "one shot game", but the program would probably produce the most robust, trustworthy and reproducible results that community ecologists can offer.

Werner (1998) gave out numerous examples on how he and his colleagues have explained and predicted several ecological patterns in artificial as well as natural settings of northern USA, and to conclude we will contribute an own ecological example on the interplay of observational, experimental, and theoretical approaches. Domestic grazing is the main economic activity in the central Monte desert of Argentina, which affects several components of the flora and fauna (Pol et al. 2014). For example, it consistently reduces the production and abundance of grass seeds (and more inconsistently of forb seeds too) in the soil seed bank of that semiarid region. In a comparative assessment of three different Monte locations, Sagario et al. (2020) reported that the abundance of two seed-eating bird species (*Saltatricula multicolor* and *Zonotrichia capensis*) decreases systematically under heavy grazing. Previous (descriptive) studies of the diet of those species in grazed (Marone et al. 2017) and ungrazed habitats (Marone et al. 2008) suggested that whereas *S. multicolor* is an obligate grass-seed specialist, *Z. capensis* is an opportunistic seedeater, with a generalized diet that includes both grass and forb seeds (Marone et al. 2008; Ríos et al. 2012). Given that species that consume grass together with forb seeds have a higher resource base in grazed habitats than species that only consume grass seeds, the "theory" based on the specialist against opportunistic behavior of consumers was unable to explain and predict the reductions observed in the density of *Z. capensis*. This bird, with a broader potential diet, should not be affected by grazing or should be affected to a lesser extent than *S. multicolor*. Experiments on seed preferences by both bird species confirmed that *S. multicolor* is an obligate grass-seed specialist, but they also showed that *Z. capensis* is not a proper opportunistic feeder but an expanding grass-seed specialist (i.e. a species that prefer large and medium-sized grass seeds but also consume less-preferred seeds like tiny grass or forb seeds when the preferred seeds are scarce or absent in its habitat). Descriptive studies are unable to detect the expanding specialist behavior, but it arose in preference trials where the amount and disposition of seeds are experimentally controlled. Experiments led us to introduce changes in our theoretical background, incorporating the expanding specialist strategy, and such changes allowed us to explain the reductions (initial observation) in the abundance of *Z. capensis* in the grazed habitats. This species would also have been tracking its preferred grass seeds, even though it can consume other seeds and, therefore, it abandoned heavily grazed areas. This interplay of observations, experiments and theory produced a reliable, reproducible scenario, where prediction was founded on both rational and empirical grounds.

5. Conclusions

At the end of a revealing article on the lack of reproducibility of research results in various disciplines, Lehrer (2010) suggested that researchers like to pretend that their experiments quickly define the truth for everyone, and that this is the reason why the decline effect (i.e. the reproducibility crisis) is so troubling. But, according to Lehrer (2010), it is not troubling because it reveals the human fallibility of science or because it reveals that many of our most exciting theories will soon be rejected. The decline effect is troubling, Lehrer (2010) said, because it reminds us how difficult it is to prove anything. The emphasis STT makes on the worth that both rational and empirical support have when used simultaneously to test scientific ideas could leave "the proof" as close to truth as it is humanly possible.

Acknowledgments

We wrote this assay to celebrate Mario Bunge's 100 birthday on September 2019. Bunge has been considered "the philosopher of the practicing scientist" because he applied himself to the commendable task of associating both traditions in fertile ways. Philosophers attracted by the comfortable project of radically criticizing the foundation of scientific knowledge usually look at Bunge's work with suspicion, blaming him of having avoided the "true" complexity of the development of human knowledge. Criticism is a philosophical duty always welcomed, and the invitation to avoid automatisms is an essential contribution of the philosophy of science to practicing scientists. However, criticism is in better company when it is accompanied by positive proposal. Criticism and construction of a philosophical foundation for science and technology have been the passions of Mario during his life, a life full of intellectual courage. Contribution 109 of the Desert Community Ecology Research Team (Ecodes), of IADIZA-CONICET, and FCEyN Universidad de Buenos Aires. CONICET (PIP 12-469) contributed to the development of this project.

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