

SOCIAL DEMAND AND CONCERNS ABOUT ANIMAL BREEDING : THE ANIMAL, A SOCIAL CONSTRUCT

B. Hervieu and J. Bonnemaire

INRA, 147 rue de l'Université, 75338 Paris cedex 07, France

INTRODUCTION

Progress in technology, the functions of animals and their products, and services in society have, paradoxically, turned animals, which are increasingly appropriated and used as tools yet overlooked and ignored, into "subject" and "object" more than ever before, not only for the livestock producers whose job is to "manage" living matter, but also for the society as a whole. The scientific community, of course, cannot stay afield of this change, since it is one of the actors. Animal breeding issues that are central in long-term meeting grounds on highly varied expectations and viewpoints give us an appropriate opening guideline. Animal breeding was part of a very long history of agrarian societies gradually penetrated by new categories of players with ever more efficient tools.

THE COMPLEX ORGANISATION AND LENGTHY BACKGROUND OF ANIMAL BREEDING

Since the first animals were domesticated, animal breeding has been part of an arsenal used by humankind to guarantee adequate food supply, in quantity and quality, as well as other resources. For a very long time, controlling animal breeding, this complex "fuel" of the agrarian system, was limited to farms and villages, with a partial exception for horses (Vissac 1993). This is still the case in many developing countries. For sheep and cattle, it was in the Lancashire manufacturing zones, during the industrial development movement that 18th century England became the first country in Europe to start, timidly, organising animal breeding. Breeding practices reached the Midlands where they inspired Robert Bakewell, the founder of modern livestock breeding. But there were no scientific bases, and the system combined the three elements that make up generation process, namely, reproduction, heredity that was supposed to be the foundation of animal breeding, and environment (including feed).

Nearly a century before the Mendel and Darwin discoveries, the application of this doctrine led to social stratification among the elite farmers and their immediate clients who, thereupon, attracted other breeders from the area. The breeders' position on the hierarchy depended not only on their talents in animal breeding, but also on professional experience, the size of their herds, and the continuity in their breeding activities. This is how herds were built up by generations of farmers and farmer families. In the final analysis, a breed of farmers grew up alongside the breed of animals. For long periods of time, thus, animal breeding was fundamental to the organisation of rural societies.

With the 20th century, in the industrialised countries, as Vissac (2002) explained, the logic behind animal breeding developed from a peasant rationale, with animals produced mainly on grazing lands, natural reproduction, and breeding decisions taken individually on the basis of

morphological models to a logic based on liberal industry, collective challenges involving artificial insemination, embryo transfers, indexing, dietary rations, sanitary controls, etc. And then came the biomechanistic logic of cloning, transgenesis and control of the variables in genetic planning. Such rationale is inevitably wielded by the large industrial groups, although the animal producers will continue to serve as operators.

Through its development and changing relations with agriculture, society bore forth animal breeding, - which initially was a simple farming practice, part of the usual agricultural activities, - to what it is now, *viz.* complex organisation orchestrated by socio-political, technico-scientific and economic forces that are becoming increasingly concentrated. This concentration has an effect on the decline in breed numbers. FAO (1999) estimates that every week at least one breed of farmed animals is eliminated, and there is reason to believe that as much as 30% of the world's breeds of farmed mammals and birds are threatened with extinction. Of course the situation is different from one animal species to the other and from one country or region of the world to the other.

ECONOMIC, SOCIAL AND CULTURAL BASIS OF ANIMAL BREEDING

Various actors, multiple targets, new objectives : animal breeding is more than a question of genetics and geneticists. Gradually, new actors and new resources appeared in the saga of progeny generation. The development of agro-food industries, and trade in genetics is viewed in a globalised, but increasingly regulated context. As science and technology developed greater control, ever greater powers were bestowed on the controlling private and public organisations. This situation was expanded to include the question of patents, or at least the appropriation and/or the protection of genetic innovations. In most cases, at least for certain species such as the grain-eaters, all these elements lead to strongly concentrated decision-making.

During the last few decades, animal breeding was considered a technical undertaking, par excellence, a matter for the specialists, but that is no longer the case, the situation has changed. Changes in the context of agricultural activities and in society's expectations have convinced a whole series of players, including many newcomers, to realign their attitudes to livestock production and the related environment. This should encourage us to alter our approaches, which can be traced to a traditional model of animal management.

Animal sciences in the world of today must consider the livestock production system *in toto*, see it as a set of goal-oriented interactions organised around three pillars, *i.e.* animals, resources, people. This approach requires going beyond the biotechnical viewpoint, which is focused on biological processes underpinning performance and which undoubtedly tended to be too exclusively valued by research in the past. It must be rounded out by economic and technological viewpoints (in livestock enterprises and livestock production circuits), ecological and geographical viewpoints (related to environmental and territorial implications of livestock production and the preservation of renewable resources and surrounding areas) and also from a social science viewpoint. Due heed must be given to the historical, political, sociological, cultural, psychological and ergonomical aspects of livestock production, and the many interactions between production activities and social configurations. Animal sciences which

involve very complex human activities *e.g.* in animal production, must also be recognised as human sciences (Bonnemaire 2001).

Animal breeding, indeed, is not only a question of genetics and geneticists. It is also a question of projects, strategies, organisational processes, and the future of resources that society seeks to acquire for its future. In the world of today, society as a whole bears the weight of history, of shared projects and stakes. Society feels its involvement and quite logically wants to enter the debate through various portals. Society feels that it has a legitimate opinion to put forth, both as concerns the objectives and the means used in animal breeding. As an example, look at the vast number of new actors entering the universe of food, in other words, the world of animal production. Their numbers include spokespeople of causes related to human health (*e.g.*, physicians), environmental preservation, maintaining biodiversity, politics, consumers' interests, business, scientists, socio-cultural issues, or even the media. Newcomers of this kind upset the current situation, in other words our individual rights, duties and habits. This also means questioning the practice of the research scientists.

More generally, managing long-term strategies, without which animal breeding would be impossible, must be examined from new angles. An example: the logic of short- or very short-term financial requirements (whether it concerns sectoral agricultural and agro-food companies or biotechnology firms) should be increasingly reconciled with the logic stemming from the biotechnological and patrimonial considerations used in managing animal resources and land areas which, by definition, must be seen in the medium- or long-term. This is the price of sustainable livestock development (Landais 1996; Hubert 2001).

Genetics refocused. Thinking about the objectives of animal breeding forces us to revisit the question of differences between animal populations (following the heated debates on breeds that ran the course of the 19th and 20th centuries). What criteria are used, what are the stakes, and for whom? First, modern science and technology will increasingly show that the biological demarcation line between breeds is becoming more and more complex, and, in some case, most unexpectedly so. Second, differentiation in the role of domestic animal populations in livestock systems will increasingly, and more specifically, depend on how agricultural operators are organised, the socially defined objectives, the managerial practices and strategies, individual identification and capitalisation, etc. Geneticists must carry the debate to all these fronts. In any case, they cannot act alone. Animal resource is not only a collection of animals, but many other things as well, *e.g.* a related, ever more complex information system, a value system, a social organisation, a culture, an economy, a territory, socio-technical mechanisms. And the proportions of these components can vary greatly from one society to the next (Bonte 1995).

We must tackle the task of constructing new "management objects", in other words, animal populations as part of systems. Actually, with reference to the animal population, we are all summoned to think in depth about "resources" as "common goods" for actors and consumers who have social, economic and also territorial organisation (Hervieu and Viard 2001).

Reflection on the objectives of animal breeding obviously include questions of goal diversification, *e.g.* from the qualitative aspects of production to disease resistance, or

ethological fitness, be they related or not to the notion of “animal welfare”, etc. Production targets become more complicated every day, and must be coupled with new objectives if we want sustainable development issues to become an element of animal breeding. Hubert (2001) pointed out that sustainable development does not only require “thinking globally and acting locally”, but also requires making two mindsets coincide : “think of the future, act in the present”. This means giving more specific attention to certain risks and how they are apportioned to and accepted by various social groups. For over two centuries, production was organised on the basis of wealth allocation and distribution; now we see that it is also organised in terms of risk-sharing.

According to Thompson (1997), animal breeding should complement its classical resources-oriented strategy (with resources being duly qualified and identified) with a strategy that emphasises a prospective systemic approach which includes human activities and, even more important, their impact. In this vein, more attention to the specificities of country situations in both the North and the South could be very instructive. For animals and their environments, the situations, advantages and constraints are not the same. The strategy on the world trade checkerboard for animal products as well as for genetics is not either. And the same undoubtedly applies to the specifications different societies assign to their livestock industry. We need to be able to construct genetic strategies that are better adapted and less standardised than in the past. After all, animal breeding draws its basic sap from diversity, doesn't it?

Until very recently, the orientations and resources of animal breeding were mainly located in the developed countries and were keyed to improving their production chains. Results have been more than visible. They have even been spectacular. In Europe, milk production more than doubled in 20 years (Faye and Alary 2001), and hence, for several decades animal breeding in the North tended to be considered as a cure-all. This meant that most genetic improvement policies in the South were based on crossing the region's animals with improved animals from the North. But even after some dozens of years, the results of these efforts are still sparse. With some rare exceptions, like zebu crosses, we cannot say that any synthetic breed has established itself permanently. And yet, highly accelerated urbanisation in these regions of the world requires rapid increases in milk and meat supplies. According to Coleou (1996, 2001), 80% of the world demand increase during the next twenty years will be coming from the South. For meat, this has meant recourse to fast growing species (poultry, pigs) which, unfortunately, are grain-eaters, and thus compete directly with people for their food. Moreover, they are reared in a highly monetised system, and require major technical and organisational attention (Faye and Alary 2001). For dairy products, urban needs are immense and will have to be met through the development of periurban dairy production. It is noteworthy that in Addis Ababa for instance, 21% of the dairy products consumed are produced locally, and that in the outskirts of Nouakchott, the dromedary, traditionally an animal of the wide open rangelands, is now raised as a high potential dairy cow (Faye and Alary 2001). In the immediate future, thus, large-scale recourse to crossings with improved breeds from the North will continue.

To meet these countries' expectations, modern animal genetics should undertake the vast, urgent job of identifying, characterising and improving local genetic resources, because unlike

20th century Europe, agricultural modernisation is not being accompanied by industrial growth capable of – even anxious to – absorb the labour force as it leaves the rural areas. Thanks to modern tools now available in genetics, we can make a much more precise inventory of the genetic variability of local breeds. From now on we should work more on the genetics of the physiological functions – in particular adaptation – found in the genetic make-up of these variable breeds, and reassess, in the South, a series of physiological approaches (*e.g.* differences in adaptation through physiological management of water needs in sheep populations may considerably enhance the animals' capacity to exploit the grazinglands; similarly, there may be gradients of tolerance to heat and to brackish waters, etc.).

Livestock development, thus, should not strive for structural concentration or maintain an exclusively sales-oriented vocation. In so far as possible it should maintain jobs and resources in the rural areas. The multifunctional dimension of animal production, and thus, diverse capacities for adaptation must be carefully maintained.

ON QUESTIONS OF ETHICS AND THE REDEFINITION OF THE ANIMAL IN THE MODERN SOCIETY

Fragmentation of the objects of animal breeding, and the question of life forms. Traditionally, animal breeding has been mainly focused on animal populations and farmers associations. Gradually, as means of actions became more sophisticated, the objects of animal breeding were fragmented, and technological control of the conditions and modalities of reproduction was acquired in the process. In one century, the gene, previously part of a purely formal concept, was turned into an autonomous object that now, in a way, has become available and can be conserved, multiplied, altered, even independently transferred from its original organism. As Chevassus-au-Louis (2000) wrote, this is the first step in appropriating life, and mastering its “elementary particles”. He went on to say that cloning provides the second step by opening the door to the carbon-copy reproduction of efficient individuals whose characteristics have been examined. Last, he added, the third technical step in this appropriation of life (which makes it possible to control progeny generation, *e.g.* inhibition of reproduction through hybridisation or polyploidisation) has almost been completed for certain animal species such as duck, fish, oysters.

The development of the various animal generation controlling instruments required took a long time. But questions on their validity and utility only came up recently. The introduction of artificial insemination undoubtedly contributed to making the generation process abstract and standardised, and to confusing representations. It did not motivate society to query animal generation. Furthermore, questions from society mainly concerned the human species. Chevassus-au-Louis (2000) ultimately summarised awareness of the collective stakes of animal generation control into two central questions : Who owns life? How extensively should life be modified?

These complex questions are worth considering from various angles, especially, the legal, economic, social, technical and ethical angles. In any case, they lead to reexamination of the status of the animal, and it is striking to see how energetically societies are tackling these

issues, in response to the recent crises (especially BSE and foot-and-mouth disease) in European livestock production.

The rights of living matter need to be examined. This is an issue worth expounding upon. Protection of “living matter” by patents – it is significant that this term is being used more and more – is becoming commonplace. Thus, in a period of 50 years, the status of “living matter” seems to have shifted from that of a concept of a natural object, whose components could be “discovered” but not appropriated, to that of an “invention” by a human industry and as such, qualified to be as strictly protected as any other original human creation. With this in mind, domesticated animal populations are to be separated from natural resources and should be treated as the outcome of several hundreds of years of collective investment in empirical, and then scientific and technological domestication, thereby legitimately qualifying them for recognition and remuneration (Chevassus-au-Louis 2000).

More generally, since the Bakewell times, economic goals have always been in the forefront of genetic improvement in the developed countries. But improvement measures were soon robed in finery to show that living matter was never remodelled without social and cultural aims. The complex societal bases of genetics are reflected in animal esthetisation and its symbolic-cum-emotional importance to animal breeding, social dynamics, debates on breed organisation and the concurrent efforts to define ideal breed types and livestock specialisation (standardisation-specialisation link), and overvaluing animal breeding by considering such work well done as something exceptional and within the technical capacity of very few operators.

For close to two centuries, esthetisation of bred animals (Mayaud 1997) made up a sort of transition phase between the olden times, when an animal was sacred, and gradual reification, when it was viewed as a source of profit. The owner of a “handsome animal” probably considered the esthetic quality of the animal-product as a way, to a certain extent, to exorcise the removal of the animal from the realm of the sacred and mitigate the process that places the animal completely in the realm of merchandise and economics. The era we live in awakens us to the speed and difficulty which societies such as ours have in redefining the animal, and the complex relations between it and us.

The ethics of animal breeding : questions on the livestock production profession and how to reconnect with the life forms. The question of ethics is extremely difficult to unravel because explaining and reaching a consensus on the underlying referents can be more easily done for people than for animals. This issue is henceforth omnipresent and concerns changes in the livestock production profession and the role that society assigns to it, as well as changes that societies make in the status of the animal. It is from these angles that animal breeding, in particular the “tools of the trade” are now being taken to task.

Production is at the heart of the livestock profession, but in modern society, animal output is not what concerns our contemporaries most. For the first time in the history of civilisations, people on whole continents and sub-continents have been living for generations as if they were sure to be able to eat and drink as much as they want, until death do come. Two generations have never experienced food shortages. Two successive generations that are not worried about

what they are going to eat today or tomorrow, since they know they are going to eat, and as for the people who do not eat – because unfortunately such people also exist – the problem is access to food, because they are excluded from access although the food is there, or could be. This amount of assurance and obliviousness are new to history, so new that one might provokingly ask whether the nutritional well-being (or relative well-being) of such a large percentage of men and women (with the corollary being unprecedented increases in life expectancy) constitutes a radical turning point in the history of humanity which has long been bedevilled by hunger and malnutrition. This highly significant phenomenon is causing a recognition crisis in the agricultural world. Since we know how radically the context has changed, we cannot imagine that our view of the food producer has not changed. We are very far from weighing the effects of all that.

We must admit that the final goals of the farmers' and breeders' processes and thoughts – the production goals that constitute their core profession – are not really shared by contemporary urban society. Yet, whenever attention turns to the means involved, everybody is interested, because that is a question of life. Actually, in our developed society, what the farmers and breeders consider to be “means” are what the rest of society thinks of as “ends”, and vice versa.

Everything seems to suggest that the traditional, absolutely moral legitimization of the final goal of livestock production has become less important than the stronger moral legitimization of respecting different forms of animal life and the requirements of human health. These latter have reached the status of unquestionable goals of general interest, absolute moral imperatives, while the former – food production – falls in a category more coincident with individual interests that, although legitimate, are first and foremost individual.

Giving front stage attention to life for life's sake can be explained not only by the fact that the food production imperative has been relegated to the wings, but also by an equally fundamental phenomenon which has upset representations of our society during the last generation, namely the question of human reproduction and death. We have supplanted a society in which birth and death were part of fatality by a society in which human reproduction is increasingly well controlled (in particular thanks to earlier scientific research and innovations stemming from work on domestic animals). Procreation management is now under control and problems of sterility are being gradually overcome. This means that procreation now involves decisions, rather than fatality. Similarly, when we consider all the points of view and disciplines that are connected to death, we come up with extraordinarily diverse and contrasted definitions of death, although they all recognise that death does not only depend on fatality or the natural life cycle, but perhaps in half the cases, at least to some extent, it also involves decision-making. This has been a radical change that contributed to putting human life, as such, but also animal life, and living conditions at the heart of society's concerns and priorities. It also explains why some of our fellow citizens do not consider it absolutely moral, essential and legitimate to design breeding methods mainly to produce farm animals. Everyone knows that no profession is an end in and of itself, and no profession can determine the social usefulness of a trade; society must be the judge. Livestock production and breeding are no exception.

The fact that animal breeding affects agriculture, and thus, affects nature, makes it all the more difficult to persuade society to share, and even accept innovations in this field. Messages between agriculture and society have become somewhat confused. Urban societies dwell in an artificial environment, and, as was said, perceive food as something abstract. But the more these societies get detached from real nature, the more they dream about “natural Nature”. With the help of the media, they construct their own order of Nature in their mind’s eye. Thereupon, the urban society puts the rural society in charge of managing nature through a rather paradoxical message: be more modern and, at the same time, more conservative. With the help of a certain scientific and technological vision of progress, the rural society must take nature as a tool, which stands for modernity, but as the steward of an eternal order of the fields it must ensure the maintenance and preservation of Nature. Paradoxes of this type also exist in the world of science, nourished by two professions : agriculture and research science.

Variations and uncertainties concerning the status of the animal in contemporary society.

To better understand what societies expect from animal breeding methodologies, there is one key question which is often hotly debated, namely, the status of the animal. The omnipresence of the “animal welfare” issue amplifies discussion which often feeds on confusion between strictly ethical questions and the many changing desires of society, as Burgat (2001) points out. This ambiguous term, “animal welfare” represents an effort to define a half century of change – with regard to bio-ethology, adaptation, anthropomorphisation and intersubjectivity – that escapes us and, in short, involves three changes in the representation of the animal.

In the post-War period, we were still living with two categories inherited from the traditional societies, *i.e.* :

- 1) Wild animals, that were foreign and/or hostile to the world of humans, yet rather close to it and, in any case, known and often hunted;
- 2) Domestic animals, appropriately named since they indeed were close (in all senses of the word) to the house (*domus*). These animals were the objects of a relationship based on familiarity; they usually had a name and were considered as both material assets and living beings. The right to kill them could be exercised without formal rituals. Production animals were the traditional servants of rural society, highly valued and given an unassailable legitimacy and moral status for their role as providers of food, products, services and various resources.

Modern society has upset the system by recognising three, rather than two categories of animals. With the economic expansion of the “Thirty Glorious Years” (1945 – 1975), a trilogy was created :

- 1) Wild animals are still present but less close, less well known and more mythified.
- 2) Domestic animals have become known as production animals (or animals kept for profit), viewed from a less “domestic angle” and used increasingly as material instruments. Their name has often been replaced by a number. The animal has become a piece of material for the geneticists and the experimenters throughout this period of reification. All that was brought about in the name of a higher moral imperative, *i.e.*, developing agricultural productivity and agro-food economies to provide large quantities of good quality, inexpensive food for the producer country, the rest of Europe, and hopefully beyond. Animals are no longer “slated to

die”; death is mechanically administered. They are no longer “sacrificed” or even “killed”, but are “slaughtered” (and nowadays in times of crisis, “destroyed”). Divesting animal death of its symbolism was started in our societies by concealing and automating it. Furthermore, as meat packaging and preparation disguise origin, we sometimes wonder whether eating meat means eating an animal.

3) As if to make up for the “identity annihilation” of the aforementioned animals, and their “deconstruction” through certain industrial production systems, we invented the pet, which has its own name, sometimes two. Pets have close relations with people, so close that one often asks whether they belong to the same species ! This clearly shows that the basic question is managing living matter in daily life. The “household pet” is gradually and increasingly anthropomorphised and integrated into the family yet, at the same time reified. Its soaring contribution to the veterinarian’s income and to profits for the pet food industry are evidence of the role it has acquired in society in just a few decades.

Actually, this second period is marked by a growing dichotomy in the relationship between people and their domestic animals.

In recent times, a five component pattern has gradually been taking shape:

1) The wild animal – having been studied, discussed, protected, photographed, hunted, – undoubtedly is becoming more visible in representations and even increasingly re-mythified as “natural Nature” becomes more remote and fills us with nostalgia, and as television, other media and travel make us more familiar with exotic animals, and as ecological awareness runs through our daily life. This brings up the question of reappropriating knowledge of the wild animal and, at the same time, animal conservation management that will automatically generate tension and heighten conflict (but also, interest and rapprochement) among, for instance, bio-ethologists, ecologists, hunters, farmers, environment managers, tourists, etc.

2) The production animal : the intensive “version” – strongly present though scarcely in sight – is highly specialised in food production, but the reification-abstraction process applied to these animals is increasingly contested and re-examined (also because of certain negative impacts on the environment). This is somehow related to food abundance, because the moral requirement, which justified the abstraction-industrialisation-artefactisation of animals, in other words, the moral imperative to feed humanity and attend to its welfare, is being revisited since the goal has been attained. Furthermore, as of the 1970s, our food became much more “processed”, much more abstract and more steps away from the producer of the raw material, in some cases, less recognisable, even unrecognisable. At this same time, two other moral imperatives cropped up, two new perspectives, neither of which expressed doubts about the “abstraction” process. One involved using the animal in human therapy, in other words, the animal became material for use in human healthcare (more or less directly, *e.g.* certain animals were used in medical or pharmaceutical experimentation). The other viewed animals as tools for landscape maintenance and territorial management, and as essential components of harmony with nature, and harmony between humankind and nature.

3) Out-doors extensive livestock farming (where the animal is considered to be a tool for land management and environment preservation or, in any case, a symbol of an activity that has been visibly and tangibly reintroduced in nature for both the farmers and the rest of the population), may constitute a new future for some of the production animals, and may serve to

restore animal status. This is a way of recognising that the domestic animal has been a partner in the development of rural civilisations for many centuries. The development of intensive, soil-less livestock production, the increasingly remote relation with food, and the concealment of death further estrange man from nature. This change in the way our contemporaries view life forms, animals and nature constitutes a major cultural change. Nature is no longer perceived as a realm of its own, nor exclusively through its direct functions for humanity, in other words, in a utilitarian manner as an exploitable source of food and protection, but rather as an environment to live in. Hence the expectation that domestic animals will recover their earlier role in this new order of things. For most of our fellow citizens, the farmed animal, halfway between wild animals and pets, can again serve as a source of mediation, and a pacifying link between animal nature and human nature, between “animalness” and “humanness” (Porcher 2001). The invisible links, made of labour, love and intersubjectivity, have been produced by a long common history. Because of these links, farmed animals, after being re-introduced in nature, participate in both the animal world and the human world, and thus, in the construction of our identity and the social bonds within our societies.

4) The “therapeutic animal” makes up the fourth category, an emerging category that is enslaved to the higher moral imperative of human life and health.

5) As for the household pet, it has become totally assimilated by today’s societies and, at least in our minds’ eye, seems to belong more to the world of people than to the world of animals. In any case, it has become a full-fledged actor in city life, a member of a “social group” that networks through numerous links (emotional, environmental, financial, logistic, political, regulatory, etc.) with the other components of urban society. The pet, both highly anthropomorphised and reified, a humanised figure in our relations with the animal world, nevertheless seems so badly denatured that, during the last few years, (as if the existing range of pet choices was not enough), a new sort of animal has been produced, a pet that is completely artificial, even virtual: the robotic pet ! The relation between our societies and their pets has, perhaps, pushed the limits of anthropomorphising to the extreme.

CONCLUSION

This socio-historical vision of the animal as a social construct only seeks to contribute to the geneticists’ understanding of the political, ethical and ideological context which receives their scientific progress, progress that has facilitated and accelerated this economic evolution that, in turn, made it socially acceptable, or not. This movement is challenging our scientific practices. We understand that we need the point of view of ethics to build up our position, but that this viewpoint does not reflect prior or untouchable transcendence, because our vantage point is also the fruit of social construction. Law, from time to time, establishes codes and dictates standards, but only if preceded by debate and arbitration of opinions. The scientific community, thus, will have to accommodate the points of view of various disciplines in order to offer our fellow citizens more than fragmented, partial inputs from the science of living matter, and to offer them the first step in an integrated approach to our discoveries.

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