

# Innovation and ethics: animal experimentation in rabies diagnosis

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## Abstract

Interdisciplinary approaches are emphasized in health communities, addressing the (re)emergence of various infectious diseases stemming from the human-animal-environment interface. An example is rabies, a serious zoonotic disease considered endemic in Brazil and globally neglected. Both epidemiological surveillance and confirmation of this disease rely on laboratory diagnosis, typically involving intracerebral inoculation of the suspected sample into mice, despite the availability of alternatives such as validated molecular techniques, recognized by the World Health Organization. This paper discusses the ethical implications of (not) adopting these methods, assuming that all animals should be respected and understood as unique individuals in their perception of the world rather than research subjects. This corroborates the need for new perspectives that redefine relationships between humans and non-human animals, which is key to introducing systemic, ethical-political changes aimed at ending animal instrumentalization, including within scientific contexts.

**Keywords:** Rabies. Animal experimentation. Animal use alternatives. Ethics, research. Human-animal interaction.

## Resumo

### Inovação e ética: a experimentação animal no diagnóstico da raiva

Abordagens interdisciplinares são enfatizadas nas comunidades de saúde, atentando a (re)emergência de diversas doenças infecciosas que emanam da interface humano-animal-ambiente. A raiva, zoonose grave, considerada endêmica no Brasil e globalmente negligenciada, é um exemplo. Tanto a vigilância epidemiológica quanto a confirmação dessa doença dependem do diagnóstico laboratorial, realizado mediante inoculação intracerebral da amostra suspeita em camundongos, apesar de haver alternativas, como técnicas moleculares, validadas e reconhecidas pela Organização Mundial da Saúde. Este artigo discute as implicações éticas da (não) adoção desses métodos, partindo da premissa de que todos os animais devem ser respeitados e entendidos como sujeitos singulares em suas percepções do mundo, não como objetos de pesquisa. Esse fato corrobora a necessidade de novas perspectivas que ressignifiquem as relações entre humanos e animais não humanos, o que é primordial para o estabelecimento de mudanças sistêmicas, de caráter ético-político, que visem o fim da instrumentalização animal, inclusive no contexto científico.

**Palavras-chave:** Raiva. Experimentação animal. Alternativas ao uso de animais. Ética em pesquisa. Interação humano-animal.

## Resumen

### Innovación y ética: la experimentación animal en el diagnóstico de la rabia

En las comunidades sanitarias se está haciendo hincapié en los enfoques interdisciplinarios, considerando la (re)aparición de diversas enfermedades infecciosas que emanan de la interfaz hombre-animal-medio ambiente. La rabia, una zoonosis grave, considerada endémica en Brasil y desatendida en todo el mundo, es un ejemplo. Tanto la vigilancia epidemiológica como la confirmación de esta enfermedad dependen del diagnóstico de laboratorio, realizado mediante inoculación intracerebral de la muestra sospechosa en ratones, aunque existen alternativas, como las técnicas moleculares, validadas y reconocidas por la Organización Mundial de la Salud. En este artículo se discuten las implicaciones éticas de (no) adoptar estos métodos, partiendo de la premissa de que todos los animales deben ser respetados y entendidos como sujetos singulares en su percepción del mundo, no como objetos de investigación. Esto corrobora la necesidad de nuevas perspectivas que resignifiquen la relación entre los seres humanos y los animales no humanos, lo cual es primordial para establecer cambios sistémicos, de carácter ético-político, destinados a poner fin a la instrumentalización de los animales, incluso en el contexto científico.

**Palabras clave:** Rabia. Experimentación animal. Alternativas al uso de animales. Ética en investigación. Interacción humano-animal.

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Rabies, one of the oldest known zoonoses<sup>1-2</sup>, is an RNA virus disease that causes acute and progressive encephalitis with a virtually 100% mortality rate<sup>3</sup>. Although all endothermic animals are susceptible to infection, mammals are the only known vectors and reservoirs<sup>4</sup>.

Considered endemic in Brazil and globally neglected, rabies is entirely preventable through vaccination<sup>5</sup>. Nevertheless, it continues to have a significant impact on a wide range of human<sup>1-2</sup> and non-human animals<sup>6-8</sup>, especially marginalized beings in the Global South<sup>3,5,9</sup>. Therefore, this impact is imbalanced and intrinsically related to factors such as the animal species involved, geographical and socioeconomic location and background of the disease, whose scientific analysis is marked by animal experimentation.

In his study of rabies and the development of the rabies vaccine, Louis Pasteur reported that one of the obstacles to extending animal vaccination to humans was that while animal experimentation was permitted, human experimentation was criminal. His approach was based on trial and error, with basic analysis procedures involving the injection of numerous substances and cultures into different animals, especially rabbits, for subsequent evaluation of the outcomes<sup>10</sup>.

The French scientist lived in the 19th century, when there were no legal protocols in place regarding the ethics of experiments or standards for research involving human and non-human animals in the pursuit of scientific knowledge<sup>10</sup>.

Currently, although alternatives are available, animal experimentation for rabies involves the use of newborn (1 to 3 days old) or weaned (21 to 28 days old) mice<sup>11,12</sup> for the performance of the mouse inoculation test (MIT), a confirmatory test for negative or inconclusive results previously indicated by a preliminary test, typically the direct fluorescence antibody (DFA) test<sup>13</sup>.

Besides the assumption that MIT is, in itself, an unacceptable and cruel practice, as it involves the unnecessary use, confinement and death of non-human animals, the insistence on using this technique is aggravated by the fact that there are validated alternative methods that avoid such violence. In 2019, the Central Laboratory of the state of Paraná (Lacen/PR) replaced this practice

and became the first public health laboratory in Brazil free of animal experimentation in rabies diagnosis<sup>14</sup>. However, there is evidence that MIT continues to be used in Brazil in several laboratories charged with diagnosing this disease<sup>15,16</sup>, despite its unethical nature.

## Method

This paper drew on an extensive non-systematic literature review of studies on the ethics of rabies-related animal experimentation. The search was undertaken in databases such as Medline, Lilacs and SciELO as well as in different works on ethics and moral philosophy. Also analyzed were documents published by Brazilian and international health institutions such as the World Health Organization (WHO), the Pan American Health Organization, the World Organization for Animal Health and the Brazilian Ministry of Health.

Based on this analysis, a critical and ethical reflection was proposed regarding an alternative for the use of mice in rabies diagnosis, based on an example of ethics applied to a real-life context, with data from the Brazilian laboratory Lacen/PR.

## Rabies in Brazil

Globally, 99% of human rabies cases result from bites by infected domestic dogs<sup>5</sup>. Consequently, a significant part of the effort in disease control and prevention is targeted at these animals<sup>2</sup>. Improved control of urban rabies in Brazil was achieved with the creation of the National Rabies Prophylaxis Program in 1973, which, for example, introduced rabies vaccination for dogs and cats nationwide, significantly reducing rabies cases in these animals<sup>17</sup>.

The current epidemiology of the disease, therefore, focuses on the sylvatic transmission cycle, especially involving bats, raccoons, non-human primates, foxes and other wild canids<sup>18</sup>. Since 2004, both in Brazil and throughout Latin America, bat-mediated rabies has been responsible for nearly all human rabies cases<sup>1,17</sup>, predominantly concentrated in the North and

Northeast regions<sup>19</sup>. These animals are identified as maintainers of rabies in herbivores, especially cattle, which are considered accidental hosts due to the expansion of livestock farming in Brazil<sup>18</sup>. Mice, in turn, are used in laboratory diagnosis to confirm infection.

## Laboratory diagnosis of rabies

Laboratory diagnosis of rabies involves many functions and responsibilities. Besides receiving and processing samples for disease confirmation, it plays a key role in identifying viruses, setting biosafety standards, developing new methodologies, validating techniques and providing essential data for laboratory surveillance of zoonoses of public health interest<sup>11</sup>. Both the WHO and Instituto Pasteur de São Paulo—a leading laboratory in Brazil and Latin American—recommend conducting two rabies diagnosis tests: a preliminary test and a confirmatory test if the first one is negative or inconclusive<sup>20</sup>.

In Brazil, DFA has long been used as a preliminary test and MIT as a confirmatory test<sup>13</sup>. The latter has the advantage of detecting the rabies virus in samples with low viral concentration. However, its disadvantages include the time required for completion, the cost and the constant need for a large number of mice, not to mention the ethical issues involved<sup>20</sup>.

MIT uses five to ten weaned mice or a litter of infant mice per sample. These animals, not always sedated, are placed in the prone position, with the researcher holding the scruff of their neck and pressing their head against a surface to keep it fixed and enable the necessary technical precision.

Intracerebral inoculation of 0.01 to 0.03 ml of the solution, which can be done in a biosafety cabinet or on the laboratory bench, is performed with an insulin syringe, with the needle inserted in the midpoint of an imaginary line between the right eye and the right ear<sup>11,12</sup>. The animals are then observed and evaluated for at least thirty days<sup>21</sup>. Those that develop neurological signs or die within the expected observation period of the test require diagnostic confirmation for

rabies, which can be done by collecting the brain for evaluation in a new DFA test<sup>11</sup>.

## Alternative methods and the pioneering work at Lacen/PR

For the confirmatory rabies test, it is recommended that, whenever possible, MIT be replaced with alternative methods<sup>22</sup> such as virus isolation in cell culture (VIC)<sup>21,23</sup>. *This method is faster, simpler and less costly for isolating the rabies virus than MIT<sup>24</sup>, besides being equally sensitive<sup>25</sup>.*

It is noteworthy that according to Article 32, paragraph 1 of Law 9,605/1998 (Environmental Crimes Law), a significant milestone in the individual protection of previously overlooked species<sup>26</sup> and in the necessary adoption of alternative techniques in education and research<sup>27</sup>, it is a crime against fauna *to carry out painful or cruel experiments on living animals, even for educational or scientific purposes, when alternative resources are available<sup>28</sup>*. In other words, failure to use existing alternative methods is considered abusive or improper animal experimentation. However, the acquisition and maintenance of cell lines are cited as the main challenges in implementing VIC in routine laboratory practice to replace MIT<sup>20</sup>.

Nevertheless, in 2018, the WHO published new guidance recognizing reverse transcription polymerase chain reaction (RT-PCR), whether conventional or real-time (qPCR), as a valid primary technique for post-mortem rabies diagnosis in both human and non-human animals and an alternative to MIT<sup>22</sup>. To this end, labs should carry out internal validation by comparing results of disease-positive and -negative samples achieved with different techniques, thus ensuring precision and reliability and adapting to the local epidemiological specificities of each laboratory<sup>29,30</sup>.

In this context, Lacen/PR, a regional leading laboratory, in collaboration with the Centers for Disease Control and Prevention, carried out a comparative study between these two techniques, aiming to validate and implement qPCR to replace MIT, a goal that was met in the

second half of 2019<sup>14,31</sup>. Thanks to this pioneering research in South America, Lacen/PR became the first public health laboratory in Brazil free from animal experimentation in rabies diagnosis<sup>29</sup>. Subsequently, in 2021, Centro de Diagnóstico Marcos Enrietti, a laboratory of Agência de Defesa Agropecuária do Paraná in charge of diagnosing rabies in herbivores, also introduced this replacement, becoming the first national agriculture network laboratory to do so<sup>32</sup>.

Besides avoiding the use of nearly 26 thousand mice per year, Lacen/PR's initiative has resulted in several advantages, such as an 80% reduction in result release time<sup>31</sup> and a 50% decrease in costs<sup>14</sup>. Benefits related to biosafety are also noteworthy, as MIT procedures pose risks of self-inoculation and there is no efficient way to avoid self-injuries with needle syringes other than careful handling and good inoculation skills<sup>11</sup>.

Moreover, violent and repetitive practices in short periods of time, such as intracerebral inoculation, which involves pain and suffering, and the need to “euthanize” numerous mice after sterilization with the equipment used, may lead to significant emotional distress among lab workers<sup>14,29</sup>. It should be noted that the use of the term *euthanasia* in animal experimentation practice is questionable. The Brazilian philosopher Sônia T. Felipe suggests *biocida* as more appropriate, as death is not caused merely in the interest of individual that is dying; rather, *it is inflicted upon the animal to eliminate traces of mistreatment, maiming, contamination and destruction caused by the experiments*<sup>33</sup>.

Nevertheless, the use of alternative techniques to MIT seems to be limited to a handful of Brazilian laboratories, including, in addition to those mentioned, the Rabies Laboratory of Instituto Evandro Chagas and Instituto Pasteur de São Paulo<sup>15</sup>. Therefore, the persistence of this practice evidences the force of speciesism, since, besides legal issues, there are alternatives that do not involve violence, enable faster diagnostic results, and are less costly and equally effective, directly impacting public health. This begs the question: Are the decisions made by researchers and managers based on their individual views or due to the difficulty in and resistance to using new techniques they do not master?

## Non-human animals and morality

Efforts to guide behavior based on the best possible reasons, assuming that the interests of affected individuals are equally important, relate to the *minimum conception* of morality—a starting point for any theoretical discussion about individual behavior<sup>34</sup>. Traditional moral philosophy, grounded in anthropocentric-speciesist ethics, presupposes that the full enjoyment of certain biological, physiological and psychological abilities, such as belonging to a particular species, language and rationality, defines the space occupied by non-human animals and humans within morality<sup>35</sup>.

It is noteworthy in this respect that simply belonging to the human species does not ensure equal moral consideration among its members, given the different minority political groups, powerless and underprivileged, historically disregarded and marginalized<sup>9,36</sup>. According to Bones and collaborators<sup>27</sup>, banning unethical research involving the exploitation of non-human animals depends primarily on our moral progress.

The unsupported claims of the French rationalist philosopher René Descartes that language and thought are prerequisites for consciousness and, consequently, the ability to experience pain attempted to convince part of society that non-human animals are irrational automatons, akin to objects and devoid of sentience<sup>37,38</sup>. Obviously, such a mindset has systematically and erroneously legitimized a number of violations of their interests.

On the other hand, the British philosopher and jurist Jeremy Bentham, one of the theorists of classical utilitarianism—which considers the consequences of actions—argued that the capacity to suffer (and to experience pleasure) rather than to reason or speak was the determining factor for an ethical duty of compassion towards non-human animals<sup>36</sup>.

Although the subject has been addressed since antiquity, it was only from the 1970s that the inclusion of non-human animals in the sphere of human morality became established as an issue of practical ethics and contemporary animal rights. In this context, the English psychologist and philosopher Richard Ryder, inspired by the

book *The Duty of Mercy*, written in 1776 by the English musician and theologian Humphry Primatt, coined and systematized the concept of speciesism. Primatt's work criticized ethics based on appearance, i.e., the act of inflicting pain and death on non-human animals simply because they do not belong to the human species<sup>39</sup>.

Ryder, who initially supported the use of non-human animals in research, realized that there was no specific term for this kind of discriminatory and demeaning behavior. Therefore, he proposed the word speciesism to designate this prejudiced and condescending treatment of non-human animals solely based on their species<sup>39</sup>. Additionally, throughout the 1990s he developed his theory of "painience" to grant rights to all living things capable of feeling pain<sup>39</sup>.

This new ethical parameter, which excluded reason, language or consciousness, made it possible to include living beings susceptible to experiencing various forms of suffering within the sphere of moral consideration<sup>35</sup>. Adopting a utilitarian viewpoint, the Australian philosopher Peter Singer<sup>40</sup> popularized the concept of speciesism in his groundbreaking book *Animal Liberation*, originally published in 1975. He draws on informative data to show the various unjust and humiliating conditions to which non-human animals are subjected to satisfy human activities.

Committed to the three pillars of ethics (universality, public justification and impartiality), Singer established the principle of equal consideration of interests as a guide in his defense of using reference utilitarianism to address ethical dilemmas. This includes the issue of animals, but not exclusively, as it respects the preferences and interests of sentient beings, both human and non-human, affected by actions<sup>40</sup>. For him, it is sentience that determines an individual's place within the moral sphere rather than aspects related to full possession of reason and language, as traditionally considered in moral philosophy<sup>41</sup>.

In this regard, experiments on non-human animals cannot be ethically justifiable solely because they benefit humans in any way. After all, when an animal suffers, *there can be no moral justification for disregarding that*

*suffering*<sup>42</sup>. From this viewpoint, based on the moral status of equality, *moral rights are the same for all who have them, even though they might differ in many aspects*<sup>43</sup>. In other words, arbitrary criteria related to morally irrelevant issues, such as biological traits, are unjustifiable when they violate the rights to life, physical integrity and freedom.

A further contribution to the philosophical debate initiated by Singer was the book *The Case for Animal Rights* (1983) by Tom Regan<sup>44</sup>, an American philosopher and animal abolitionist who coined the term "subject-of-a-life" as a criterion for equality of rights among individuals. His work played a key role in increasing interest in the study of ethical issues related to the treatment of non-human animals, both within and outside academia<sup>45</sup>.

Through their principles of animal liberation—Regan's deontological proposal recognizing the inherent value of *subjects-of-a-life* and Singer's utilitarian proposal based on sentience—these authors were essential to expanding the moral community beyond human animals. However, they argue that *feelings are not what compel humans to recognize the inherent equal value of animals and their right to be treated with respect*<sup>46</sup>. Thus, both reject the role played by emotions, often associated with femininity, and by contextualization within animal ethics.

On the other hand, they appreciate aspects typically associated with masculinity, such as autonomy, abstraction and rationality<sup>47</sup>, thereby acknowledging, to some extent, the sexism that prevails in traditional ethical-political debates, which often naturalize practices based on abuse of power, exploitation, domination and oppression. Furthermore, they overlook the significance of feminist movements in the fight against animal exploitation.

A case in point is the social mobilization against vivisection and the role of suffragettes in England<sup>48</sup>, such as the writer and anti-vivisectionist Francis Power Cobbe, who addressed animal welfare as a moral philosophy and founded the first Society for the Protection of Animals in that country, precisely due to the use of animals in scientific experimentation<sup>49</sup>.



According to Cudworth<sup>50</sup>, exploitation is understood as the use of something as a resource; domination as systemic relations of power that constrain the flourishing of an individual, group or landscape; and oppression as a severe level of domination and its materialization in specific species. Both feminist (political and non-academic) and animal rights activism are directed against this institutionalized model of rationalist hegemonic thought, aiming to denounce and put an end to such practices.

This reflection on the affinities and intersections between these two groups (feminist and animal rights), stemming from the different forms of violence they undergo in social relationships, gained attention during the feminist movements of the 1960s and was reinforced by eco-feminist writings in the 1970s<sup>45,48</sup>. Since then it has included discussions on animal ethics, such as the aforementioned works by Singer and Regan.

This does not mean that action should be guided solely by emotions; rather, other elements that are part of morality—such as care—should be considered to better guide decisions in moral dilemmas. One of the most controversial issues in modern society concerns the use of non-human animals in education and biomedicine. In this practice, mice and rats, sentient and conscious mammals, are the most exploited animals, accounting for up to 95% of all animals used in laboratories<sup>45</sup>.

### Bioethics and animal experimentation in the context of rabies

Scientific experimentation is the second largest human activity in the world in terms of animal exploitation, second only to the agri-food sector<sup>52</sup>. Despite being the forms of speciesism that cause the most animal suffering and are therefore at the core of this issue, both these activities are encouraged, tolerated and even funded by taxes<sup>40</sup>.

In the scientific field, experimentation occurs in education (teaching and training), research and testing, affecting approximately 500 million living non-human animals per year<sup>35</sup>. These animals are used in tests for cosmetics, chemicals, toxicity, allergies and diagnostics,

among others. Often, these experiments do not contribute significantly to relevant medical research<sup>40</sup> or to ensuring safety, efficacy and interspecies prediction<sup>53</sup>. But even if they did, *that would not justify violating the rights of animals who are unfortunate to find themselves in a laboratory cage somewhere*<sup>54</sup>.

Deemed to be quite an ancient practice, animal experimentation became a standard in biomedical research<sup>53</sup> as of the 17th century. Alongside human cadaver dissection, it was used to gain knowledge about human body functions and to develop vaccines and medicines. The activity increased significantly in the 20th century with the emergence of new technologies, professions and industries based on the use of non-human animals.

Today, human experimentation is mainly used in clinical trials, which follow preclinical trials traditionally carried out on non-human animals<sup>45</sup>. On the other hand, the use of non-human animals remains widespread in the scientific milieu, even after important milestones related to animal defense, such as the 1978 *Universal Declaration of Animal Rights*<sup>35</sup>. Nevertheless, both this acknowledgement and the scientific contributions from academia on sentience, consciousness and animal welfare are crucial to support and brace the fight against speciesism.

The *Cambridge Declaration on Consciousness*, proclaimed in 2012 by an international group of 25 neuroscientists, scientifically consolidated the notion that some non-human animals—such as vertebrates and certain invertebrates like cephalopods—have similar consciousness-generating structures to humans. Consequently, this understanding expands the scientific recognition that their consciousness is similar to ours<sup>55</sup>, making them sentient beings. And since they possess consciousness and interests, their emotional state morally matters.

Despite its anthropocentric focus on anatomical similarities with humans to equate capabilities across species, and although it may fail to grasp that each animal has its own way of living and being in the world, regardless of those similarities<sup>50</sup>, the declaration is considered a landmark for animal defense. In line with this

trend, the *Curitiba Declaration*, drafted at the III Brazilian Congress of Bioethics and Animal Welfare in 2014, organized by the Federal Council of Veterinary Medicine, stated: *We conclude that non-human animals are not objects. They are sentient beings. Consequently, they should not be treated as objects*<sup>56</sup>.

More recently, in 2022, the *Montreal Declaration on Animal Exploitation*, drafted by scholars and signed by researchers and scholars in moral and political philosophy from different countries, concluded that *because it unnecessarily harms animals, animal exploitation is fundamentally unjust*. It also called for renouncing entrenched speciesist habits in order to transform institutions<sup>57</sup>.

Regarding non-human animals exploited in scientific contexts, MIT is just one of the many invasive procedures involving interventions that compromise an animal's bodily integrity, such as punctures or incisions. Virtually all these procedures result in some form of physical discomfort, ranging from mild (such as during restraint) to severe with intense pain<sup>58</sup>.

In addition, Bachinski and collaborators<sup>59</sup> point out that besides ethical considerations, using non-human animals in science can also be viewed as a methodological and biotechnological issue due to uncertainties regarding interspecies data extrapolation, exposure time and variations in gender, age and ethnicity in the human population.

Moreover, in Brazil, the ethical principles used to assess moral issues in experimentation differ between humans and non-human animals<sup>53</sup>, revealing the existence of a bioethical double standard<sup>26</sup>. The code of ethics regulating human experimentation is grounded in the four fundamental principles of bioethics—autonomy, non-maleficence, beneficence and justice<sup>60</sup>—that guide the rigorous protocols required for approving research with humans and consider the dignity and respect for the freedom of those involved.

In contrast, regulation of animal experimentation is less protective, grounded in the 3Rs: replacement, reduction and refinement of non-human animals in scientific activities. According to these principles, the ethicality of a procedure is based solely on compliance with pre-established protocols<sup>26</sup>.

Therefore, theoretically, inflicting harm on an animal is tolerated as long as it is considered essential to a particular research, test or teaching methodology.

This means that despite attempts to minimize suffering through the 3Rs, the use of non-human animals in experimentation is nevertheless legitimized<sup>61</sup>. It should be noted that only the principle of replacement is capable of furthering ethical scientific progress, as the others serve mainly as moral protection for researchers<sup>53</sup>. This discrepancy stems from a speciesist and anthropocentric conception of the dominant way of thinking and conducting science, where the ethical and legal foundation to protect individuals is based on whether or not they belong to a particular species.

Therefore, it is essential to discuss this issue from the viewpoint of ethics, as strict adherence to species membership is morally irrelevant. Sentience should be one of the main criteria in granting moral protection to any individuals involved in biomedical testing and research<sup>26</sup>. Thus, all beings capable of feeling pain and suffering, whether mentally, physically or emotionally, should be included on the same level of justice.

The specific case of rabies is complicated for involving a disease with near 100% mortality, thereby posing a serious public health problem<sup>17</sup>. Researchers might prefer to focus on this aspect to justify the use of laboratory mice (or to shirk responsibility), claiming that diagnosis must be prioritized for reasons of disease surveillance. However, this line of reasoning is unjustified from a moral standpoint, as it is both speciesist and arbitrarily weighs the harms and benefits produced by this activity.

Although the established practice provides greater safety for those who use it, that does not necessarily mean it is the best technique or ethically unquestionable. Validated alternative methods, such as molecular techniques, have offered advantages in diagnostic speed and ethical conduct in science, avoiding the suffering and death of animals<sup>14,29,31</sup>. They also benefit humans, as quicker diagnosis results in more suitable treatment and more efficient epidemiological surveillance, demonstrating a genuine concept of multispecies health.

Therefore, it is essential to understand bioethics as a field of action and study that aims to connect moral and ethical conflicts with scientific debate, seeking better solutions to encountered problems<sup>60</sup>. The determining elements of a scientific paradigm that includes, as a supposedly inevitable practice, the intracerebral inoculation of a potential rabies virus in young mice need to be thoroughly investigated.

There is no justification for this technique, whether from an ethical, legal, technical, scientific or economic perspective. Its persistence, however, calls for reflective consideration of alternative tools in order to phase out the use of mice for confirmatory diagnosis of animal rabies, the main issue discussed in this paper.

### Interdisciplinarity from a multispecies health perspective

Cooperative interdisciplinary communication, integrating knowledge from different areas for the development of more comprehensive solutions<sup>61</sup>, is indispensable in this context. Consideration should be given to the identified issues involving the current corporate agri-food system, the vulnerability of humans and the different treatment of non-human animals susceptible to rabies, according to their circumstances.

This requires looking into the intrinsic contradictions in the different forms and degrees of domination of certain species by human action, as they reveal a common logic of domination among vulnerable individuals<sup>50</sup>. It is important to highlight the ethical discussion based on vulnerability, emphasizing the condition in which an individual becomes (and not only is) vulnerable and consequently is incapable of self-defense<sup>53</sup>, as is the case of non-human animals used in scientific experimentation.

The underlying structures of speciesism and multispecies relationships, which vary according to geographical, sociocultural and gender-related aspects, justify discussing rabies based on the proposal of the Multispecies Health Network (Rede Same)<sup>62</sup>. This project aims to assist in building an alternative mindset and scientific and behavioral practice concerning non-human

animals. Within a Latin American context, this approach makes sense for contributing to and emphasizing connections between sociocultural and economic aspects as determinants of health, besides being strongly opposed to the animalization of bodies, which oppresses both non-human animals and marginalized humans.

Thus, although there is some concern for human health in peripheral areas, Rede Same denounces the systematic marginalization of non-human animals within public health, where they are reduced to instruments in the prevention and control of human diseases. This underscores the complexity of health in peripheral areas due to racial, ethnic, patriarchal and interspecies practices. In this proposal, health is not limited to humans, but rather relates to multispecies communities where individuals are not viewed as instruments or commodities and their subjectivity is respected.

Insofar as values translate into actions, they should be developed so as to consider the inherent value of the lives of other beings, preserving and respecting their uniqueness and intentions. In addition, reinforcing the role of emotions and contextualization, an ethics of care complements traditional theories by addressing important dimensions of care and personal responsibility<sup>46</sup>.

In this way, an ethics of care supports the need to adopt alternative techniques to the use of non-human animals in science. Recognizing the vulnerability of others, from their perspective and regardless of their species, would make it possible to reconsider the selfish position assumed in many aspects of human existence<sup>53</sup>.

### Final considerations

Although the Federal Constitution of Brazil generally prohibits cruel practices against non-human animals<sup>63</sup>, their use for scientific purposes has been sustained and tolerated, grounded in an anthropocentric perspective.

Resistance—individual, collective and institutional—to new ideas is also an integral element in evading necessary changes and adaptations. However, more than that, preference and choice for perpetuating speciesist practices are a reality. Moreover, such can be the immersion in



this anthropocentric bias that people are not even aware of their resistance to new ideas, as they are often simply operating within the system.

Even attempts to mitigate the suffering of these animals, as in the concern with improving cage conditions, do not make MIT any less inconceivable. Complying with animal welfare regulations does not imply the absence of stress and suffering, while cage improvements do not necessarily benefit the animals, as the simple fact of being confined prevents the full enjoyment of their natural behavior<sup>45</sup>.

In addition, Silva and Corrêa<sup>53</sup> argue that imprisonment goes beyond the cage, as the non-human animal is also confined within the mindset of contemporary dogmatic science and a political structure that supports highly questionable practices. Therefore, the oppression and exploitation of these animals involves denial of their species-specific behavior, confinement, physical harm and death.

The disclosure of such facts can contribute to ethical reflection on human actions and their criteria for laboratory practices. The evidence presented above on the implementation of a validated alternative technique shows it has a direct impact on public health, since diagnostic results were faster and as efficient as, if not better than, those of traditionally used techniques.

This technique offers reliability for everyday use, confirming rabies diagnoses with high sensitivity and specificity and eliminating the use of mice for this purpose. A nationwide survey is being conducted in Brazilian laboratories on the causes and limitations for the adoption of alternative techniques to confirm rabies diagnosis, aiming to accumulate knowledge for the implementation of the technique.

As many of our actions are driven by intuition and feeling rather than duty, in the field of biomedicine, care should be included as

an element of morality and extended beyond the beings we interact with on a daily basis. Also noteworthy is that besides the political importance of implementing alternative techniques, social pressure is essential to drive this transition. To this end, more inclusive approaches in the relationship with other living beings are essential<sup>61</sup>.

Like Regan<sup>44</sup>, we believe we have a duty to intervene and speak out in defense of animals, whether human or non-human, whose rights are violated. A critical analysis shows that speciesism is present not only in diagnosing rabies but also in defining which species deserve moral consideration and care. In this context, abolishing MIT is an ethical rather than merely scientific or economic issue.

Within the current structure, non-human animals are moral patients, meaning they are subject to the actions of moral agents, i.e., human animals, and thus we have the duty to act consciously and responsibly. Therefore, to change the conception of animals as machines for testing and research<sup>27</sup> *we need a much more fundamental shift in how we think about them*<sup>64</sup>. The existence of alternative methods makes their application morally mandatory.

Thus, abolishing the use of mice in the diagnosis of animal rabies, enabling scientific practice free from this type of exploitation, involves structural transformations where all efforts matter: individual, collective, public and private. Redefining our relationships with other beings and with the environment we share is essential to achieving, among other things, a science free from animal oppression. This entails more affective and empathetic relationships with all beings that cohabit this planet, favoring the development and application of new techniques that reconcile ethics and scientific progress, benefiting multispecies health.

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Gabriela Chueiri de Moraes designed the study, collected and analyzed data and wrote and reviewed the paper. Tatiana Tavares da Silva analyzed data and wrote and reviewed the paper.

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